GLA ECONOMICS

The environmental effectiveness of London

Comparing London with other English regions

June 2005

Transport for London

MAYOR OF LONDON

LONDON DEVELOPMENT AGENCY

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Greater London Authority
June 2005

Published by
Greater London Authority
City Hall
The Queen's Walk
London SE1 2AA
www.london.gov.uk
enquiries **020 7983 4000**
minicom **020 7983 4458**

ISBN 1 85261 741 1

Cover photograph
© VisitLondon

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GLA Economics provides expert advice and analysis on London's economy and the economic issues facing the capital. Data and analysis from GLA Economics form a basis for the policy and investment decisions facing the Mayor of London and the GLA group. The unit is funded by the Greater London Authority, Transport for London and the London Development Agency.

Contents

Foreword

There is a long tradition of cities being seen as environmentally damaging and unsustainable. William Cobbett called London ‘the great wen’, and William Morris wanted to forget the town, longing for a London that was small, white and clean. This report shows that while London, like most cities, faces formidable challenges in improving its environment and reducing the impacts it has on the rest of the country and beyond, the traditional view does not tell the full story.

As this report shows, concentrations of people and economic activity like London can enable higher environmental efficiency, whether you look at resource use per head of population or per unit of output. It shows how London’s high productivity and high value added economy is effective in environmental as well as economic terms. It also suggests that the policy set out in the *London Plan* and my *Economic Development Strategy* of investment in London supporting the success of a resource-efficient economy, is a sensible one to help meet national environmental objectives. An alternative approach of dispersing people and jobs would lose the benefits of agglomeration, lead to longer journeys and more car use, and lead to higher household energy costs.

Of course, there is no room for complacency. London faces formidable environmental challenges, some of which are highlighted in this report. We also have to confront the contribution the capital makes to national and international environmental problems like global warming. But history shows that well-informed action can be taken to promote genuinely sustainable development. We will need to harness London’s ingenuity and innovativeness to drive further improvements to the efficiency with which its people and businesses use resources, and to minimise in absolute as well as comparative terms its wider environmental impacts.

My vision for London is to see it become an exemplary, sustainable world city. Key to delivering this vision is understanding the issues underlying the environmental effectiveness of cities, and how this can be improved. This report contributes to this process.

Cities exist because they reduce costs. In doing so, they create other costs. The estimates published here are a new way of thinking about the environmental burden created by different types of places. They need to be put alongside estimates of the absolute impact on the environment of human existence and human activities. We hope that this report will make a contribution to the understanding so critical to effective policymaking and action.

Mayor of London

Executive summary

This report compares the environmental effectiveness of London with other regions in England. By estimating environmental and resource use for each region in England, and then calculating per capita and per output measures, the report concludes that London performs well in terms of environmental effectiveness.

London provides agglomeration opportunities for business and other commercial, social and economic activities. This fosters competitive advantages that allow certain business sectors, such as the financial services and creative industries, to thrive. However, with most economic activity there is a cost in terms of natural resource and environmental degradation, such as carbon and air quality emissions and the production of waste. Although London consumes a significant share of total national natural resources and contributes to environmental degradation, London produces less transport carbon dioxide (CO_2) emissions per capita and household waste per capita than other English regions. Furthermore, in terms of environmental degradation per unit of output produced, London performs the best of all regions.

This report is a first attempt to estimate the environmental effectiveness and efficiency of English regions. The initial analysis supports the view that London performs well. London does this by bringing together many people to live and to create an average income that is higher than the national average. London uses fewer resources and degrades the environment less on average than would be possible if the same economic activity was spread throughout England.

The higher usage of public transport in London leads to lower per capita and per output emissions from transport than in other English regions. There is also an indication from road transport, that as new vehicles become more fuel efficient, higher incomes in London mean that the fleet is newer on average and therefore there are environmental benefits to be gained earlier.

Some of the reports' key findings

Households:

- In 2002, household electricity consumption in London was 0.09 GWh (Gigawatt hour) per £1 million of Gross Value Added (GVA). The average in all other regions was 0.13 GWh per £1 million of GVA.[1]

- In 2002/03, household waste in London was 0.46 tonnes per capita, while the average for all other regions was 0.53 tonnes per capita.

[1] In this report, the average of all other regions is a simple average and does not take into consideration the relative size of GVA or population in each region.

- For the period 2000/01 to 2002/03, London had the second highest level of total water consumption. However, water consumption per £1 of output was lowest in London at 2.9 litres per pound (£) of GVA in 2002/03, while the regional average (excluding London) was 3.6 litres per pound (£) of GVA in 2002/03.

Transport:

- In 2003, per capita and per pound (£) of GVA transport CO_2 emissions were lowest in London at 1.1 tonnes/capita and 50.6 tonnes/£1 million of GVA (the regional averages excluding London were 2.0 tonnes/capita and 134 tonnes/£1 million of GVA).

Commercial and industrial:

- In 2002, commercial and industrial CO_2 emissions in London were 53 kilo tonnes per £1 billion of GVA. The average in all other regions excluding London was 193 kilo tonnes per £1 billion of GVA.

- Commercial and industrial gas sales in London were 238 GWh per £1 billion of GVA in 2002. In all other regions excluding London the average was 557 GWh per £1 billion of GVA.

1. Introduction

Historically London has had low environmental quality but it has also always been a centre for trade and wealth creation. London's economic and transport infrastructure has a high environmental impact in terms of total energy and resource consumption, emissions and waste generation. The environmental quality is affected not only by economic activity but also by geographical and weather conditions in London. Central London is particularly prone to the urban heat island effect due to its converging buildings and narrow streets. This restricts the dispersion of pollutants into the atmosphere.

Nonetheless, London is a vibrant cosmopolitan city with a growing population. London had approximately 7.3 million inhabitants in 2003[2]. The Greater London Authority (GLA)'s *London Plan* suggests that London's population will increase by between 690,000 and 964,000 by 2016. However, the widely accepted central scenario in the *London Plan* estimates that London's population will grow to 8.1 million by 2016.

London is the most densely populated region of England. Population density is around 14 times the average for all other regions. Nearly half of London's households live in flats or maisonettes compared to 20 per cent for the rest of England[3]. There are many factors that determine environmentally friendly practices, such as household size, property type, socio-economic status, family life cycle and access to recycling/composting facilities. Research has shown that people living in flats tend to recycle less waste, larger households produce more waste[4] and poorer households tend to be less energy efficient[5]. Figure 1.1 shows regional population and population densities for 2001.

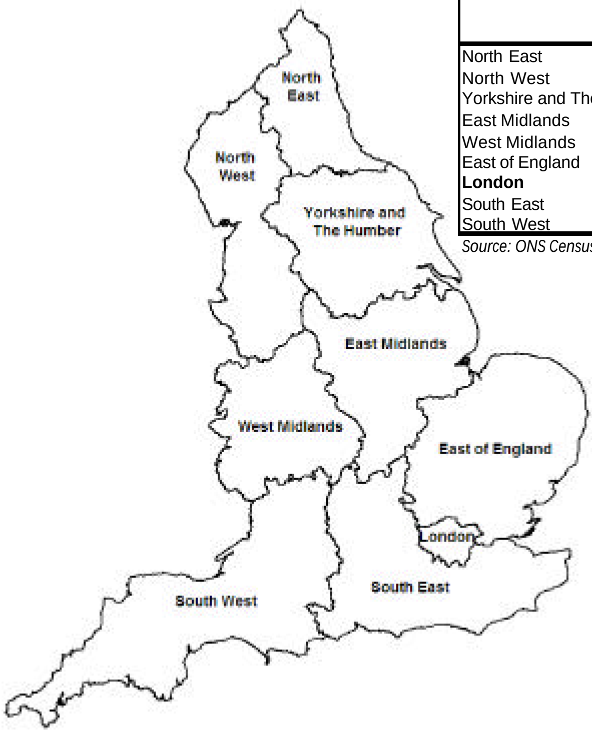
1.1 Background and purpose

Life in cities is commonly associated with congested roads, crowded trains and smaller living quarters. This invariably means that the environmental impact of urban life in terms of air emissions, waste and energy consumption is considered relatively high. Recent health evidence has shown that people in large cities on average suffer from relatively lower levels of health[6]. A recent US study[7] examining the link between suburban sprawl and physical and mental health has found that suburban living can have a negative effect on physical health. The research, which is at an early stage, points to the possibility that the urban form is a

[2] GLA, February 2004, The London Plan, The Mayor's spatial development strategy for London, pp. 24-25
[3] ONS, 2001, Neighbourhood statistics. View: http://neighbourhood.statistics.gov.uk
[4] Resource Recovery Forum, 2002, Household Waste Behaviour in London, Brook Lyndhurst Ltd. and MORI
[5] Boardman B, 2004, New directions for household energy efficiency: Evidence from the UK, Energy Policy (32), pp.1921-1933
[6] Künzli N et al., 2000, Public-health impact of outdoor and traffic-related air pollution: A European assessment, Volume 356, Issue 9232, p.795
[7] Sturm R and Cohen D A, 2004, Suburban sprawl and physical and mental health, Public health 118, pp. 488-496

determinant of physical health. More car use in suburban areas reduces walking and other physical exercise and may also lead to higher levels of air pollution. The implications for UK suburbs may be similar but not of the same magnitude to the US as the UK's suburban sprawls are not as large as in the US.

Figure 1.1: Regions and their population densities, 2001



	Population (million)	Area (mil, hectares)	Density (population per hectare)	GVA (£, Billion, 2002)
North East	2.5	0.86	2.93	29.5
North West	6.7	1.41	4.77	93.1
Yorkshire and The Humber	5.0	1.54	3.22	65.7
East Midlands	4.2	1.56	2.67	59.1
West Midlands	5.3	1.30	4.05	72.9
East of England	5.4	1.91	2.82	91.0
London	**7.2**	**0.16**	**45.62**	**146.9**
South East	8.0	1.91	4.2	147.8
South West	4.9	2.38	2.07	69.2

Source: ONS Census 2001, GVA from ONS (based on European System of accounts 1995)

However, this is not the whole story. Cities can be environmentally effective in a number of ways. Firstly, this environmental effectiveness can be seen by comparing the environmental impact of cities with the alternative of spreading every city resident over the country. Putting people close together generates lower waste or emissions per person or per pound (£) of output produced. Moreover, cities play a key role as engines for economic growth and employment. In cities, there is a concentration of economic activity and its negative environmental impact is confined to a small area relative to the size of the country. It is not obvious that this situation is worse than lowering the environmental quality of the whole nation. In other words, the trade-off between a poorer overall environmental quality in cities with a better environment for the rest of the country needs to be considered. This is particularly relevant if high labour mobility means that a relatively small proportion of people live all their lives in cities.

Secondly, London could be considered as relatively environmentally effective if its environmental impact is examined in terms of per capita or per unit of output. For example, because of the higher rate of public transport use in London, overall transport emissions per capita are lower in London than in other parts of England. Dense housing in flats and apartments should also imply that London's households consume relatively less energy and suffer from lower heat dissipation than in other parts of the country. The business and commercial activities in London are also more service based which would also imply that they consume less energy than manufacturing activities.

The main objective of this report is to compare the relative environmental performance of London with the rest of England. Environmental effectiveness in this report is defined as the efficient use of resources in terms of per capita or per unit of output produced (i.e. lower emissions and waste per capita or per pound [£] of output).

1.2 Report overview

In this report, estimates of the environmental effectiveness of London are compared with estimates for all other English regions. Section two examines the environmental efficiency of households living in London. This is analysed in terms of energy, emissions, waste, and water consumption of households. Section three looks at the environmental gains attributed to the transport mode structure and patterns in London. The relative environmental effectiveness of London's economic activity is examined in section four. The last section concludes the report by combining some of the indicators in the previous sections.

It should be noted that London is the UK's only city region, whereas the other regions are a mixture of urban and rural areas. Household, transport and commercial environmental effectiveness measures are now presented for every English region.

2. Households

London's housing stock is relatively old. Most of London's houses were built before the Second World War. This has implications for energy efficiency and thus fuel poverty for households. The following section looks at the environmental impact, in terms of energy consumption, emissions, waste and water consumption, of households in London. This will be compared with other regions of England.

2.1 Energy consumption overview

According to the Mayor of London's draft energy strategy[8], overall energy consumption in Greater London increased by 16 per cent between 1965 and 1999. However, London's population fell by seven per cent over the same period indicating that per capita energy consumption increased significantly. Since 1983, London's population has been increasing and is expected to increase to eight million by 2016. This growth in population is driving an increase in household energy use.

Despite the increase in energy usage, per capita total energy use in London is lower than the UK average. Lower per capita total energy use in London reflects the lack of energy intensive industries and a higher proportion of flats in the capital. However, total household energy consumption is higher in London because of its high population, above average affluence and relatively smaller average household size.

2.2 Household energy consumption

Household electricity and gas consumption in the UK has remained more or less constant over the three-year period from 2001 to 2003. Household energy consumption accounts for about 45 per cent of London's total energy consumption.

Household energy consumption as a proportion of income is determined by factors such as energy prices, income levels and mean temperatures. With energy prices relative to the Gross Domestic Product (GDP) deflator falling over the period 1990-2003, and with mean temperatures higher in London, Londoners would be expected to spend a smaller proportion of their income on energy now than in the past. However, a significant number of Londoners spend a relatively large proportion of their income on energy consumption[9]. Heat loss in many London dwellings is partly responsible for inefficient household energy use and fuel poverty. The Mayor of London's draft energy strategy states that poor energy efficiency in homes is one of the primary causes of fuel poverty.

Measures such as loft insulation, solar water heating, double-glazing, wall insulation and using energy-saving appliances can increase energy efficiency. It is estimated that most homes in Greater London do not have adequate insulation.

[8] GLA, February 2004, Green light to clean power, The Mayor's energy strategy

[9] GLA, February 2004, Green light to clean power, The Mayor's energy strategy, p. 28

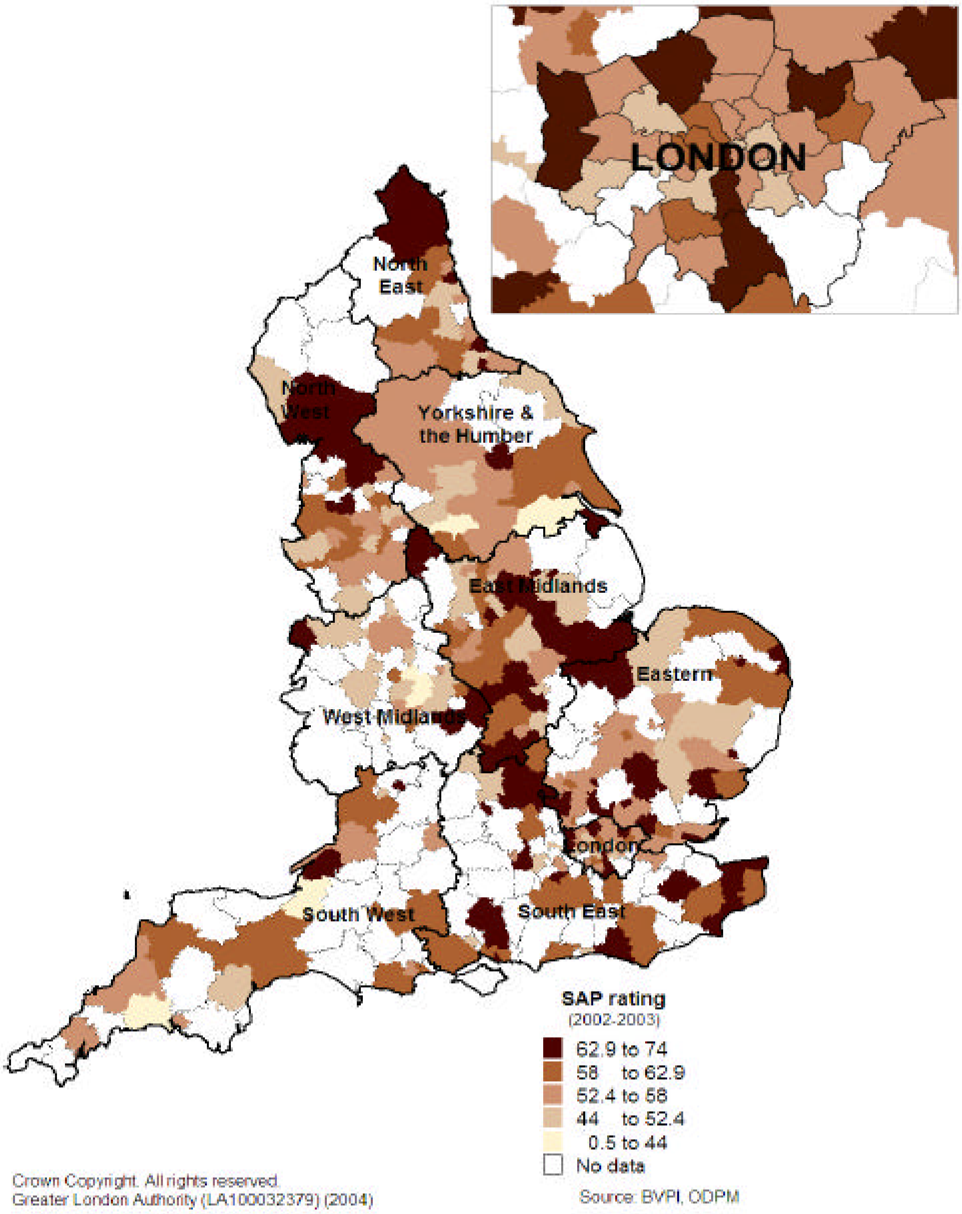
Insulation varies with type and age of property. Heat loss is greatest in detached homes, while centre floor flats generally have better thermal properties. If housing energy efficiency is analysed by occupier type or tenures, the highest proportion of homes without insulation is private rented properties. This reflects the different incentives that landlords and tenants have especially if tenants are responsible for energy costs. Tables A1 and A2 in the Appendix show the types of tenured property in different regions and energy consumption by type of tenure.

Energy efficiency in homes can be measured using the Standard Assessment Procedure (SAP) which was developed in 1993 by the Department of the Environment, Transport and the Regions (DETR) and the Building Research Establishment (BRE). SAP assesses the energy efficiency of dwellings by calculating the energy cost factor (ECF) for each home. SAP produces a rank from 1-120 with 1 indicating a very energy inefficient dwelling. The ECF measures the annual space and water heating cost per floor required for satisfactory heating. The ECF takes account of the thermal insulation of the building fabric, efficiency and control of space heating and hot water systems, ventilation characteristics, solar gain characteristics, and the price of fuels used in space heating and hot water systems. Map 2.1 shows the SAP rating for London and other regions in England while Figure 2.1 provides examples of SAP ratings. The map shows that ratings vary by boroughs in London, but the picture is similar for other parts of England.

Average SAP ratings in London indicate that homes do not have adequate insulation. When London SAP ratings are analysed by tenures, private rented homes have the worst rating. Policies to increase insulation in the private property rental sector could improve fuel efficiency in London and further reduce per capita energy use in Greater London.

Despite poor SAP ratings for London, in 2002 London had the second lowest total energy consumption (gas and electricity) per household at 23,800 kilowatts (KWh). In comparison the average household in the North East consumed around 25,100KWh of energy.

Map 2.1: Household SAP[10] rating



Notes: The average SAP rating for each local authority is shown. The highest average SAP rating is 74.
Source: BRE

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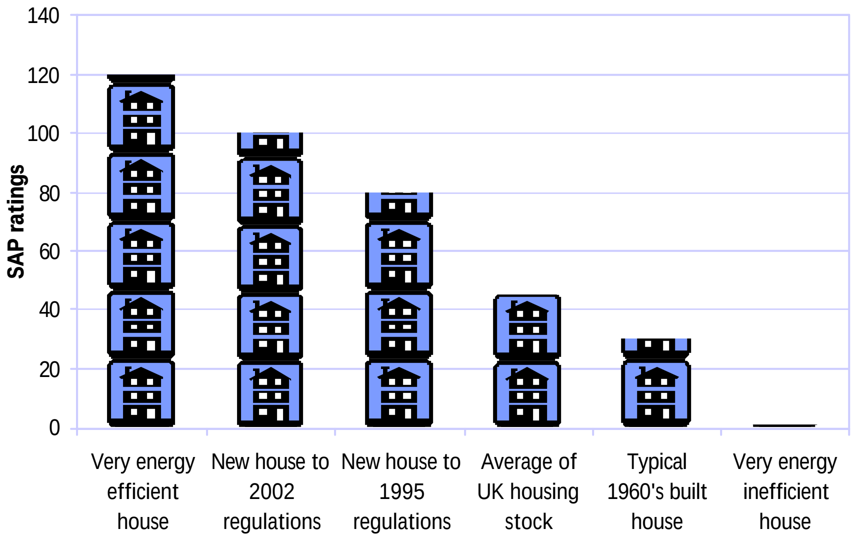
[10] The SAP for the energy rating of dwellings is a calculation of a building's energy efficiency. SAP ratings are scored on a scale from 1 to 120 where 1 is the worst and 120 the best.

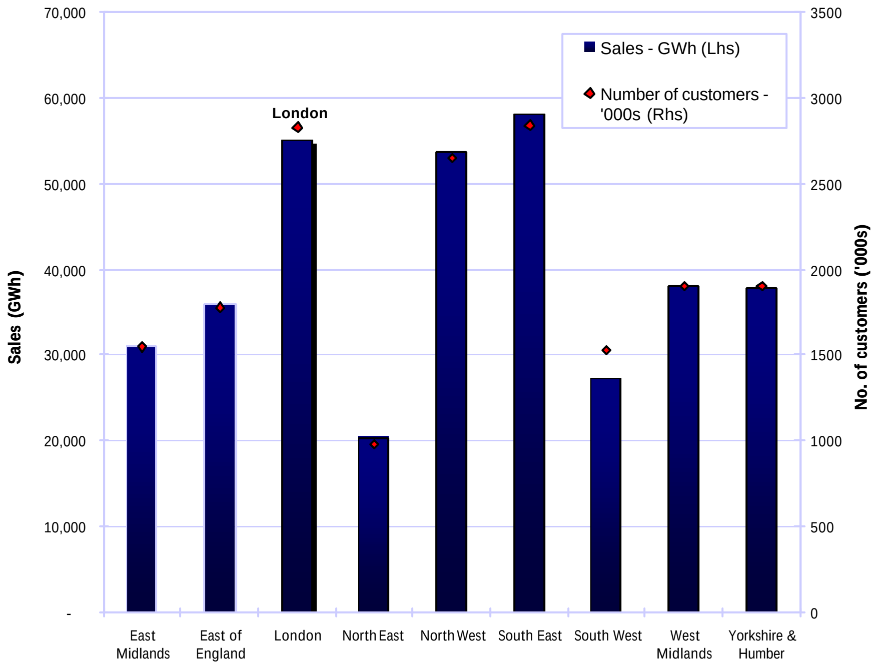
Figure 2.1: Examples of SAP ratings



Source: BRE

Figures 2.2-2.5 show gas and electricity consumption in English regions (brief commentaries are given with each figure).

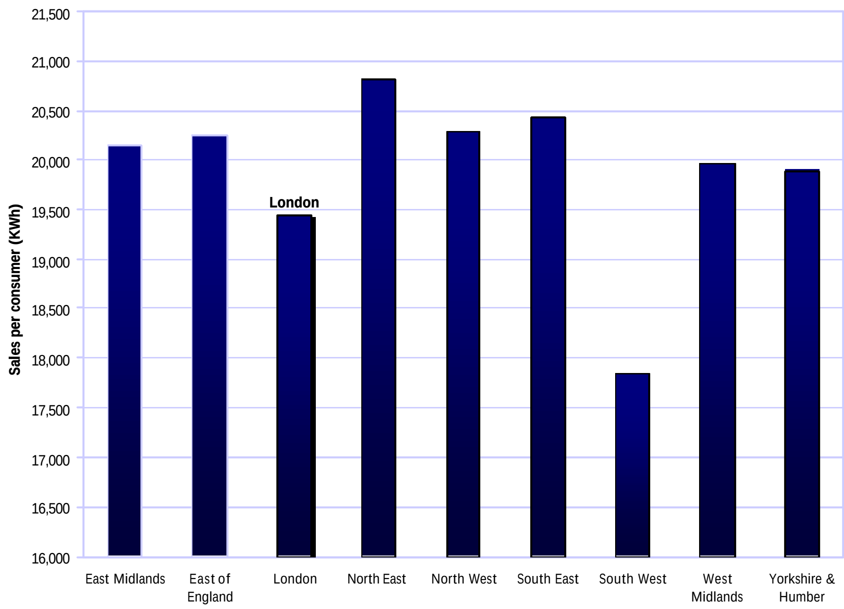
Figure 2.2: Household gas sales and numbers of customers, 2002



- In 2002, London had around 2.8 million gas customers consuming around 55,000 GWh of gas.
- The South East and London consume nearly 32 per cent of total gas consumption in England.

Source: Department of Trade and Industry (DTI), December 2003, Energy Trends

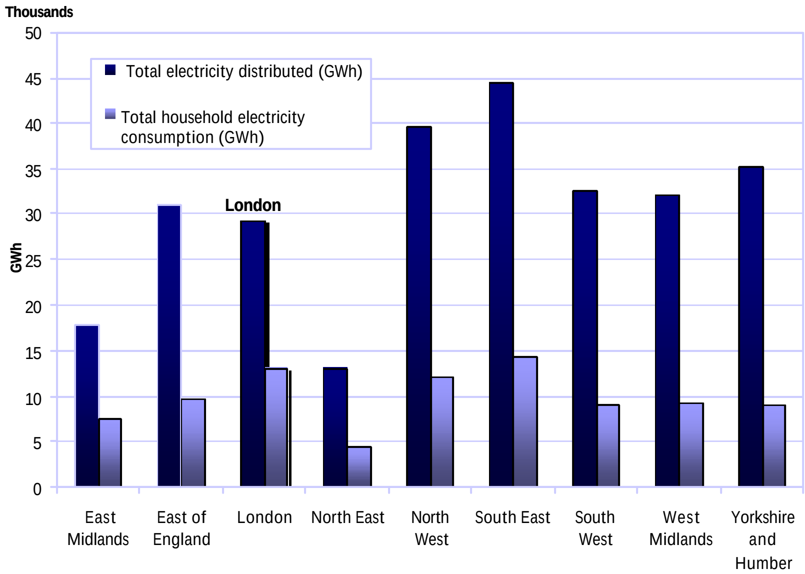
Figure 2.3: Household gas sales per consumer, 2002 (KWh)



In 2002, London household gas sales were approximately 19,500 KWh per consumer. The average in all other regions was approximately 20,000 KWh per consumer.

Source: DTI

Figure 2.4: Total electricity distribution and household consumption, 2002 (GWh)

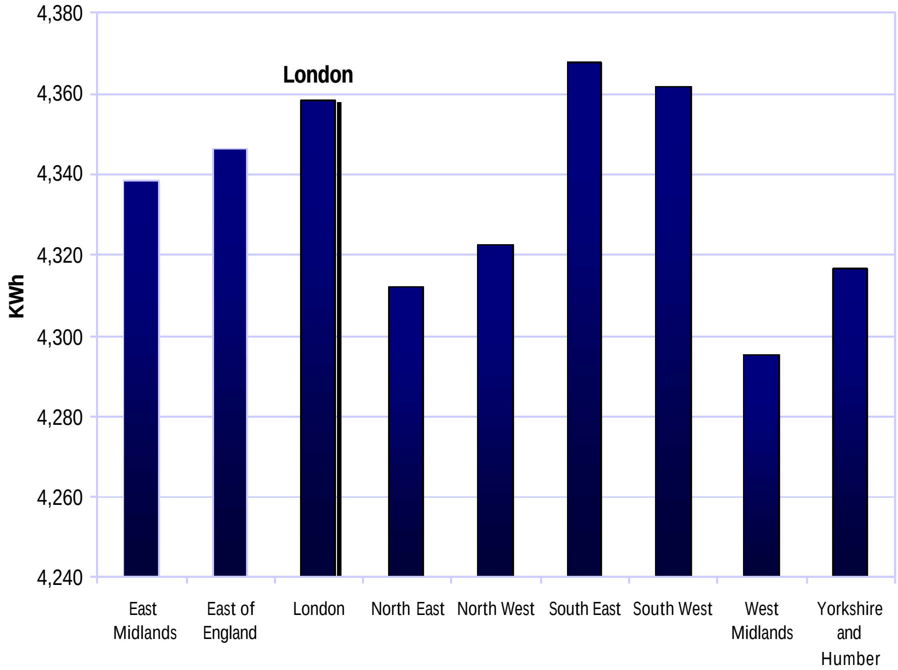


- In 2002, London households consumed 45 per cent of its total electricity distribution.
- The South East, with the highest consumption of all regions, consumed 16 per cent of total electricity distributed in England.

Notes: Household energy consumption was calculated by using BRE's energy efficiency profiles for housing stock and ONS' tenure composition of each region[11].
Source: DTI, ONS and BRE

[11] See Tables A1 and A2 in the Appendix for more detail.

Figure 2.5: Electricity consumption per household, 2002 (KWh)



London has the third highest electricity consumption per household. This is mainly due to a high proportion of private rented households which consume on average 500KWh and 1500KWh more electricity per household than owner-occupied and socially-rented households respectively.

Source: DTI, BRE and Office for National Statistics (ONS)

Household gas sales per consumer in London is the second lowest of all regions, which reflects London's lower heating usage. However, higher disposable incomes can potentially explain the high electricity consumption per household in London. Not all modern consumer electronic and electrical goods are energy efficient. For example, modern plasma flat screen TVs use six times more electricity and cost nearly five times more than conventional TVs. European Union (EU) product policy has mainly emphasised energy efficiency instead of energy conservation. This has resulted in larger appliances consuming less energy per unit of service (e.g. KWh/kg for washing machines) but has not reduced absolute consumption[12]. The propensity for buying these larger appliances and electronic goods such as plasma TVs is higher in London, which could partly explain the relatively high per household electricity consumption in London. As mentioned before, the conflict in interest that landlords and tenants have toward insulation is also a factor associated with higher electricity consumption per household in London.

[12] Boardman B, 2004, New directions for household energy efficiency: Evidence from the UK, Energy Policy (32), pp.1921-1933

2.3 Per GVA estimates for household energy usage

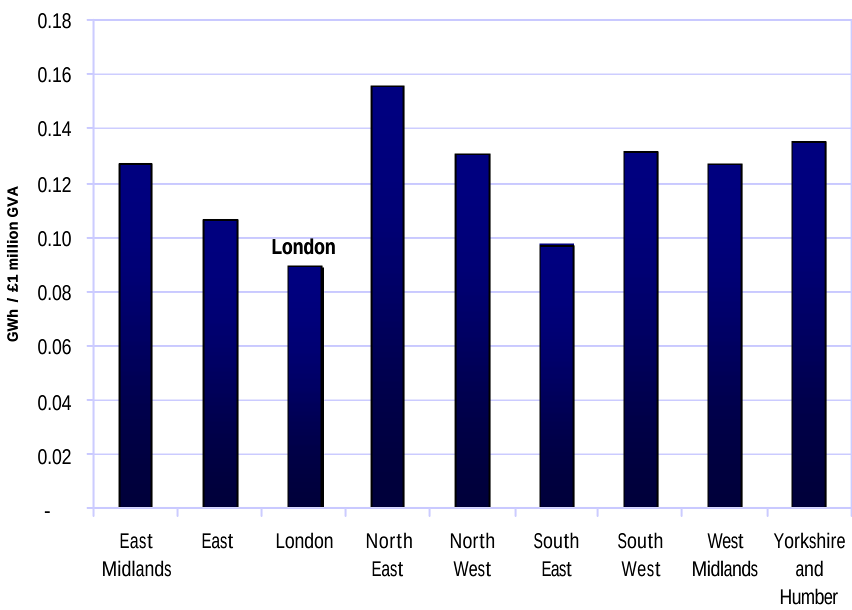
Another measure of comparing environmental effectiveness is to examine energy usage per unit of economic activity. This is done by examining the estimated household electricity and gas consumption per £1 million of GVA for all regions. These calculations have been compiled using the 2002 data on electricity distribution, 2002 data on gas sales by region and 2002 data of GVA by region provided by the ONS. Estimates of regional GVA are on a residence basis, where the income of commuters is allocated to where they live rather than their place of work.

Figure 2.6 shows electricity consumption per £1 million of GVA for 2002. London households use the least amount of energy when analysed against GVA at residence basis. London households use about 0.09GWh per £1 million of output. The average household electricity consumption in all other regions (excluding London) is 0.13GWh per £1 million of GVA.

In Figure 2.7, London has the lowest per GVA household gas sales at 0.37GWh per £1 million of GVA. The average in all other regions outside of London is approximately 0.51GWh per £1 million of GVA or 1.4 times the level of London.

There are clear benefits of energy use in London when compared on a per GVA basis. While London had the country's second highest gas usage, per GVA estimates show that London performs well amongst all regions.

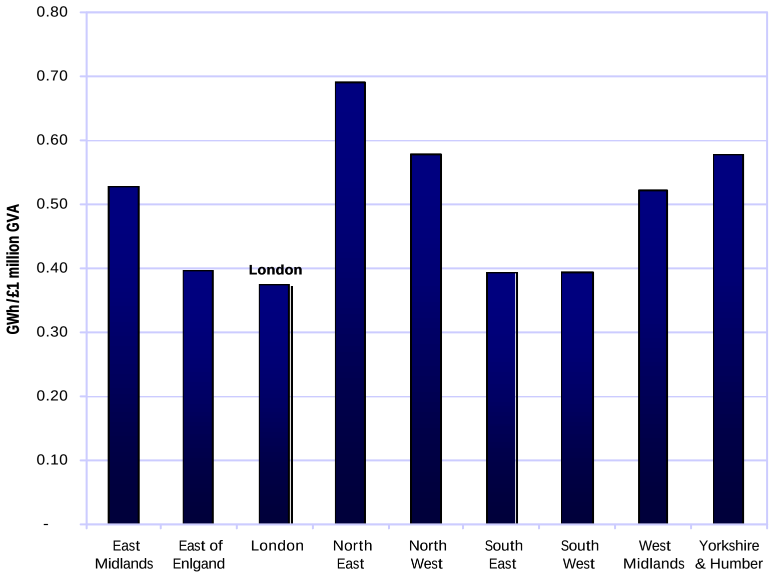
Figure 2.6: Household electricity consumption per £1 million GVA, 2002 (GWh)



London has the lowest distribution of electricity per £1 million of GVA. This is mainly due to the high level of GVA generated in London. The level of electricity distributed in London per £1 million of GVA is roughly 0.09GWh. The average of all other regions is 0.13GWh.

Source: DTI, BRE and ONS' neighbourhood statistics

Figure 2.7: Gas sales per £1 million GVA, 2002 (GWh)



London has the lowest household gas sales per £1 million of GVA. The level of gas sales in London per £1 million of GVA is roughly 0.37 GWh. The average of all other regions is 0.51 GWh.

Source: DTI

2.4 Household waste

The relative environmental effectiveness of waste levels and disposal are now examined. The UK generates approximately 434 million tonnes of waste every year[13]. According to Defra, approximately 250 million tonnes of this waste is controlled waste made up of municipal, industrial, commercial, construction and demolition waste[14]. The rest is considered uncontrolled waste. Municipal waste and waste from the commercial and industrial sectors are responsible for 27 per cent of total waste. Table 2.1 shows the approximate shares by sector of total UK waste.

Table 2.1: Sector share of waste generated

Sector	Percentage share
Agriculture	20%
Minerals (mining and quarrying)	21%
Sewage sludge	<1%
Dredged material	8%
Municipal waste	8%
Commercial	6%
Industrial	13%
Construction and demolition	24%
Estimated total UK annual waste	434 million

Source: Defra, Key facts about waste and recycling

[13] [14] Source Defra, Key facts about waste and recycling: www.defra.gov.uk/environment/statistics/waste/kf/wrkf02.htm

Most waste goes to landfills, however, households recycle approximately 12 per cent of their total waste generated. Since 1996/97 household waste has grown at almost the same rate as GDP. However, the rate of increase slowed over the years 2000/01 to 2002/03[15]. Besides economic growth, a number of factors have led to an increase in waste, these include:

- demographic changes, including the increase in the number of smaller households
- lifestyle changes such as an increase in gardening and DIY
- increased packaging
- waste management changes, including the increased use of wheelie bins
- increased non-household waste entering the household waste streams.

London produces about 17 million tonnes of waste each year. This is made up of municipal, commercial, industrial, and construction and demolition waste. Londoners produced approximately 4.45 million tonnes of municipal waste in 2002/03 or roughly 15 per cent of all municipal waste produced in England. Households accounted for about 75 per cent[16] of this waste. In London, municipal waste has grown at about three per cent per annum since 1996/97. The factors affecting the growth of waste in London are similar to the factors affecting national growth. However, in London increased population, increases in the number of households, a reduction in average household size and increased affluence measured by GVA are particularly important factors.

Figure 2.8 shows total municipal social waste (MSW) produced by the various regions in 2002/03. London is second only to the South East as a producer of municipal waste. London produced about 4.45 million tonnes of municipal waste in 2002/03, while the South East produced approximately 4.5 million tonnes. The average MSW produced in all regions excluding London was 3.1 million tonnes in 2002/03.

Figure 2.9 shows the disposal of municipal waste for 2002/03 by region. Of the total municipal solid waste disposed in England, 75 per cent went to landfill sites, nine per cent was incinerated and 16 per cent was recycled. Most waste in all regions goes to landfill sites. Generally the level of recycling is less than 20 per cent for all regions except in the South West, South East and East regions.

A disproportionately high percentage of London's municipal waste (20 per cent) is incinerated, while only nine per cent is recycled or composted. The rest, 71 per cent, went to landfill sites. In terms of total tonnes recycled, London ranks fifth among all regions. The total amount of MSW tonnes recycled or composted by London is less than half (42 per cent) of the region leader, the South East, which managed to recycle or compost 965,000 tonnes of MSW in 2002/03.

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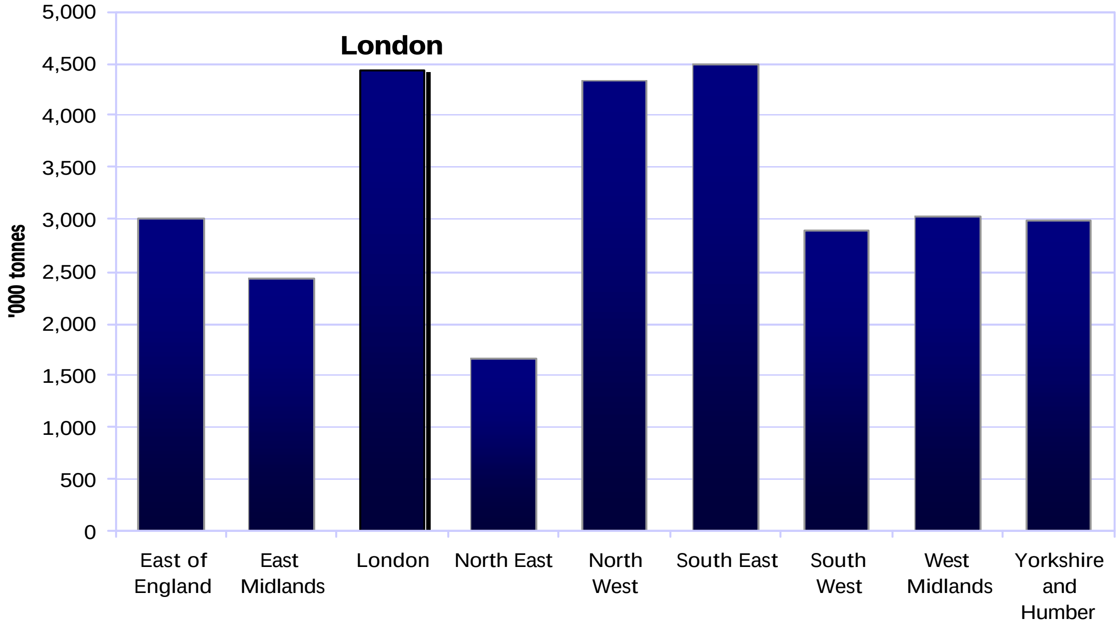
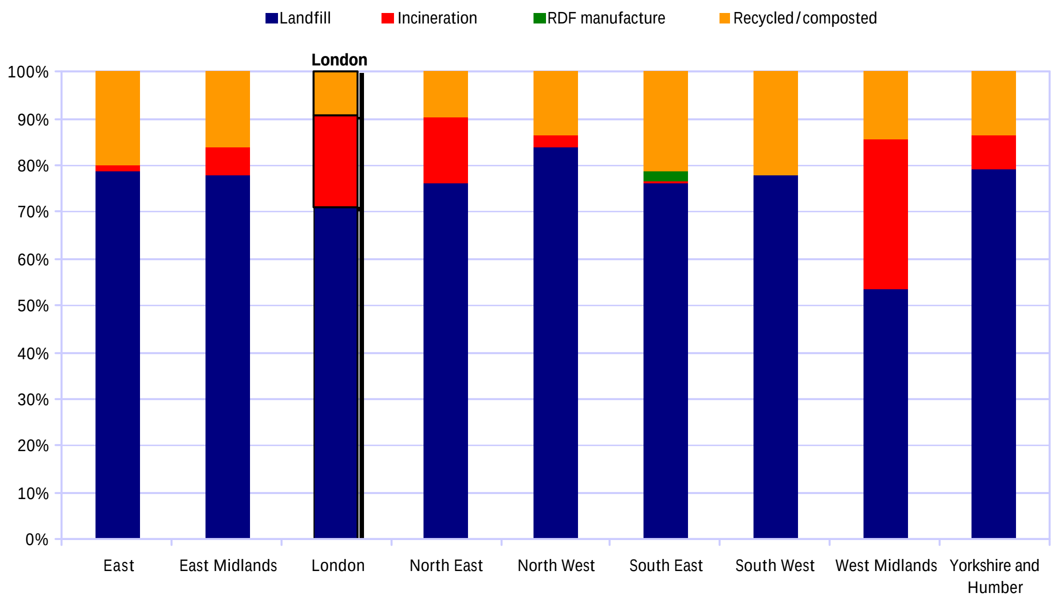
[15] Source Defra, Key facts about waste and recycling.
[16] Including waste from civic amenity sites.

Figure 2.8: Total MSW arisings (2002/03)



Source: Defra, Key facts about waste and recycling

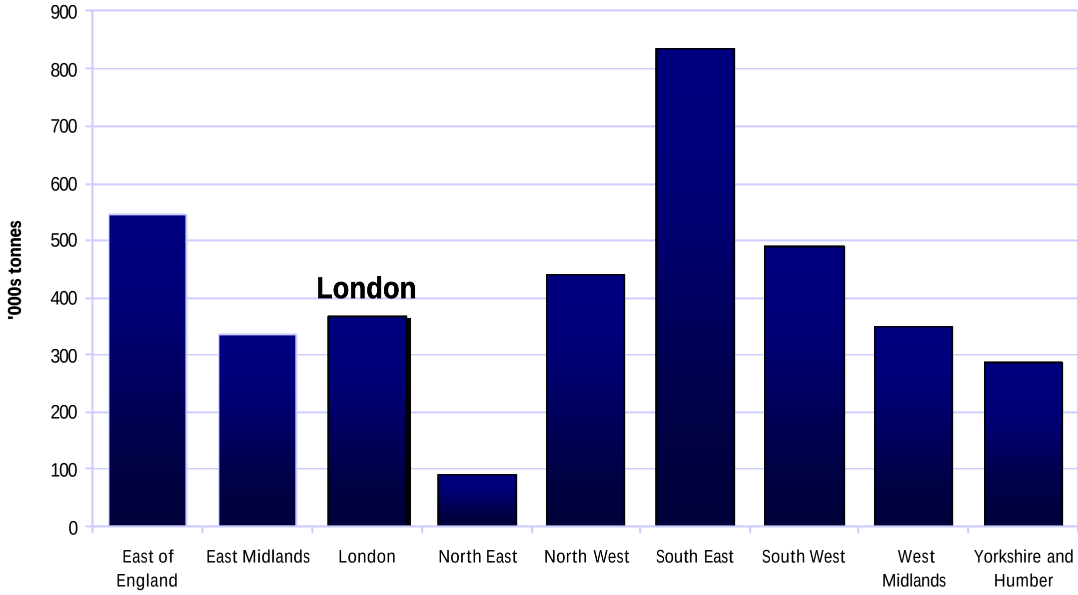
Figure 2.9: Municipal waste disposal (2002/03)



Notes: RDF = Refuse derived fuel
Source: Defra, Key facts about waste and recycling

Figure 2.10 shows actual tonnes of household MSW that were recycled and composted in 2002/03. The South East is the regional leader with 835,000 tonnes recycled in 2002/03. London recycled only 368,000 tonnes of household MSW waste. Map 2.2 gives a geographical representation of the levels of household waste recycled in England.

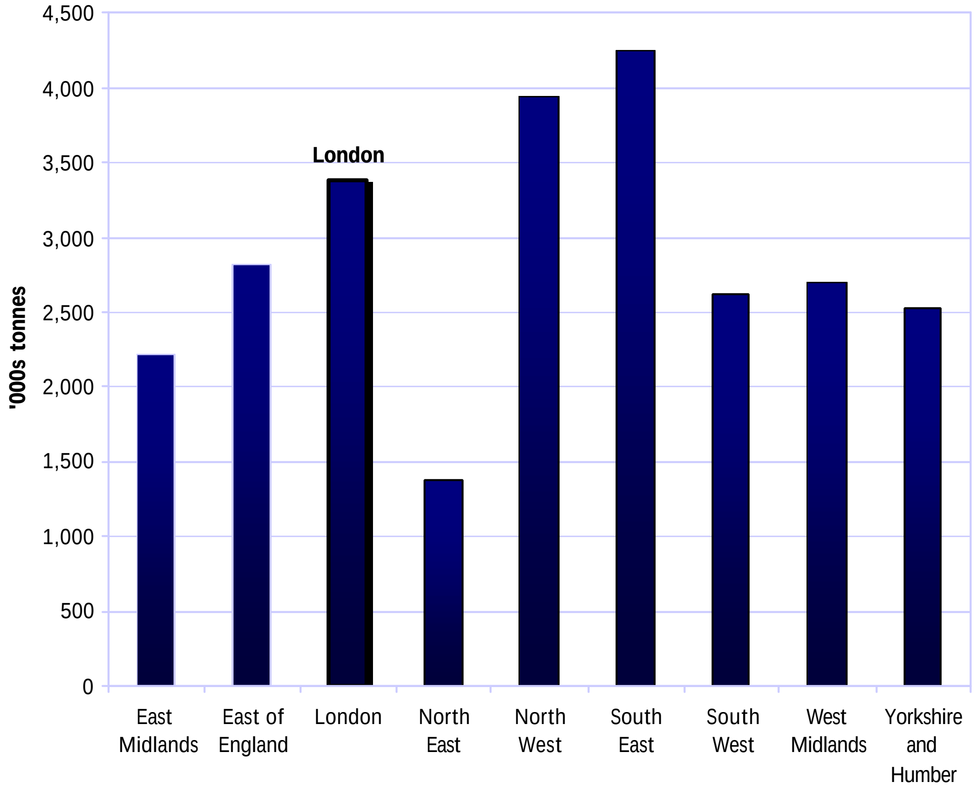
Figure 2.10: Tonnes of household MSW that are recycled (2002/03)



Source: Defra

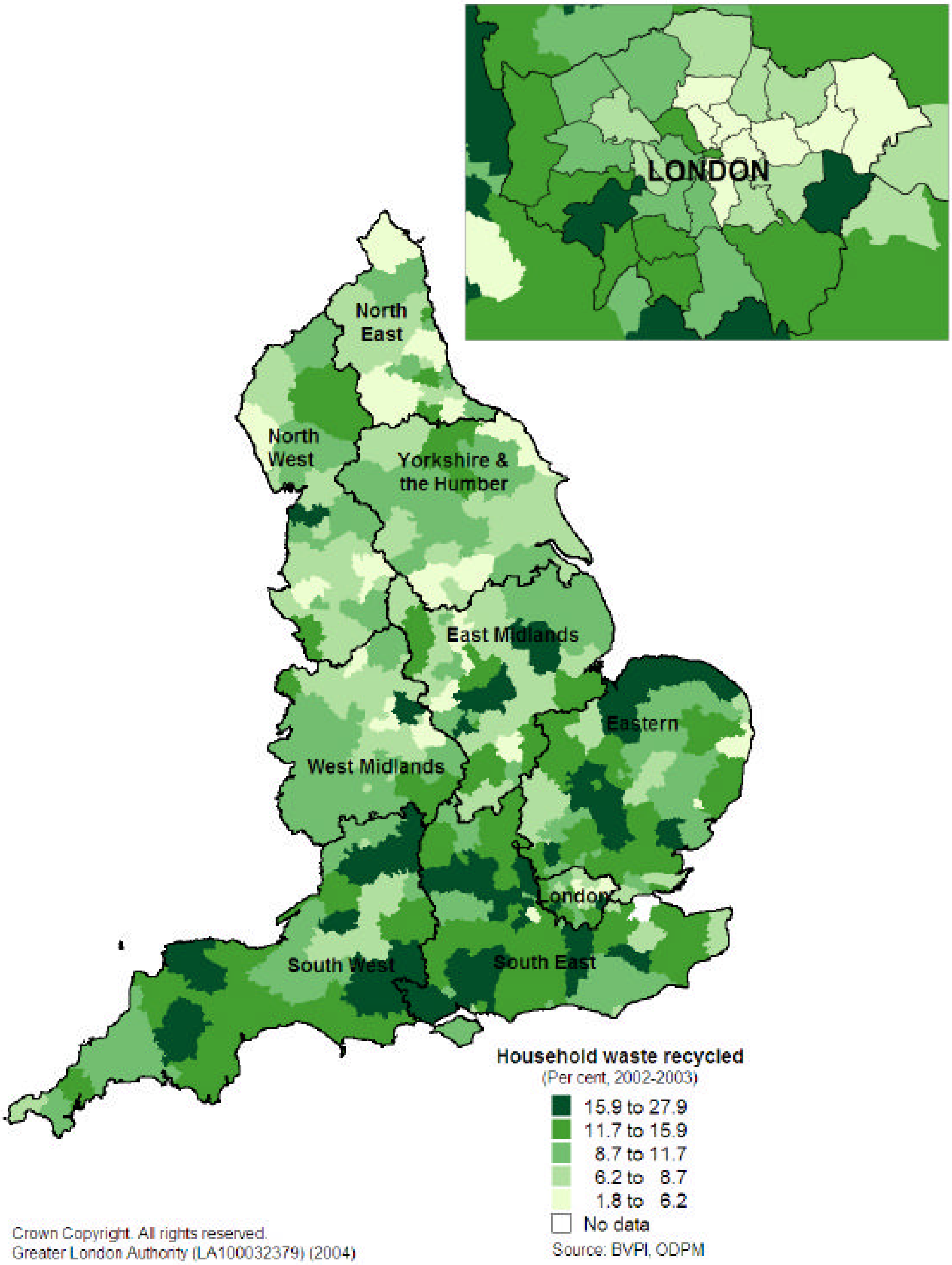
Household waste is a proportion of total MSW and is made up of regular household collection, other household sources, civic amenity sites and household recycling. Figure 2.11 shows the level of household waste in 2002/03. As a region, London produced the third highest amount of household waste, approximately 3.4 million tonnes. Only the North West and South East produced more waste, 3.9 million tonnes and 4.2 million tonnes respectively.

Figure 2.11: Household waste (2002/03)



Source: Defra, Key facts about waste and recycling

Map 2.2: Household waste recycled



2.5 Per capita and GVA waste estimates

In 2002/03, in terms of per capita household waste, London produced the lowest amongst the regions at 460kg (see Table 2.2). The average of all other regions was 530kg per capita.

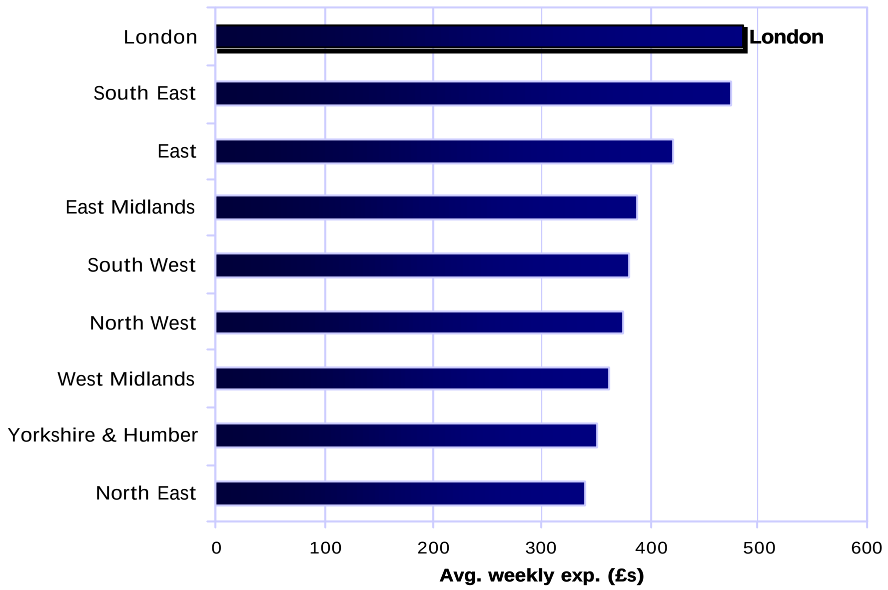
Table 2.2: Household waste per capita (kg, 2002/2003)

	Household waste, kg per capita, 2002/03
East Midlands	520
East	520
London	**460**
North East	540
North West	580
South East	530
South West	530
West Midlands	510
Yorkshire & Humber	510

Source: Defra, Key facts about waste and recycling

This data is surprising for London because affluence is high in the capital and high affluence is a major factor for waste production. However, high affluence is only one factor and there may be other factors that contribute significantly to the generation of waste. Figure 2.12 shows weekly household expenditure by regions for the years 2001-2003.

Figure 2.12: Average weekly total household expenditure (£s, 2001-2003)



Source: ONS, 2003, Family Spending - A report on the Expenditure and Food Survey 2002-2003

When Figure 2.12 is examined, a Londoners' average weekly expenditure (£486) is higher than in other regions. The average for all other regions is £386. Higher average expenditure therefore cannot explain the amount of waste generated per capita. This is mainly because household expenditure patterns differ substantially from region to region. Londoners spend the lowest proportion of their income on food and drinks compared to other regions. On the other hand Londoners spend around £44 per week on hotels and restaurants compared to an average of £33 per week for the rest of England[17].

According to the Office of the Deputy Prime Minister (ODPM)'s *Best Value Performance Indicators*[18], Windsor & Maidenhead has the highest average household waste per head while Oadby & Wigston in the East Midlands has the lowest. In London; Barking and Dagenham has the highest average with around 620kg per head while Wandsworth has the lowest at around 335kg per head.

In terms of household waste per GVA, London performs best among all regions. Estimated municipal waste per pound (£) of GVA for London and all other regions has been calculated by using 2002/03 data of municipal waste arising and 2002 GVA data for all regions. London generated about 23 tonnes of municipal waste per £1 million of GVA, while the average of all other regions (excluding London) was approximately 37.4 tonnes. This is shown in Figure 2.13.

[17] *ONS, 2003, Family Spending - A report on the Expenditure and Food Survey 2002-2003*
[18] View: www.bvpi.gov.uk/pages/Index.asp

Map 2.3: Household waste per head

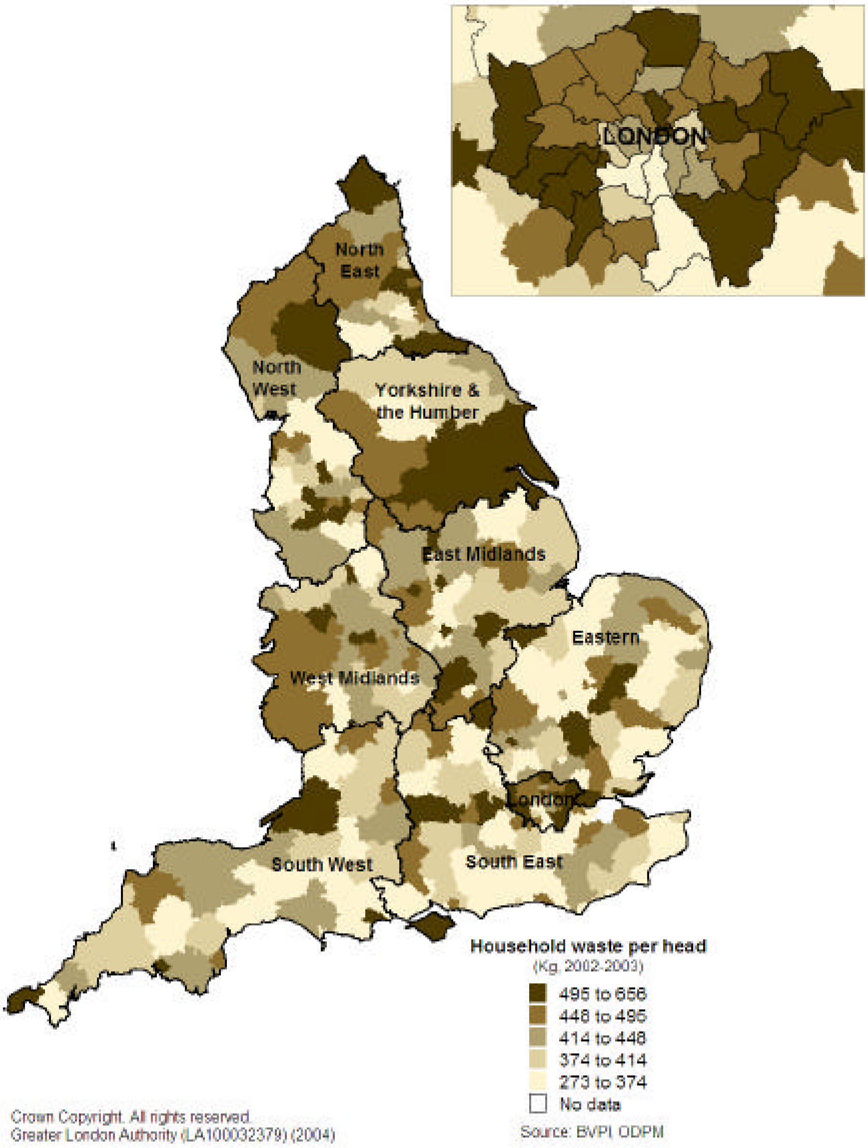
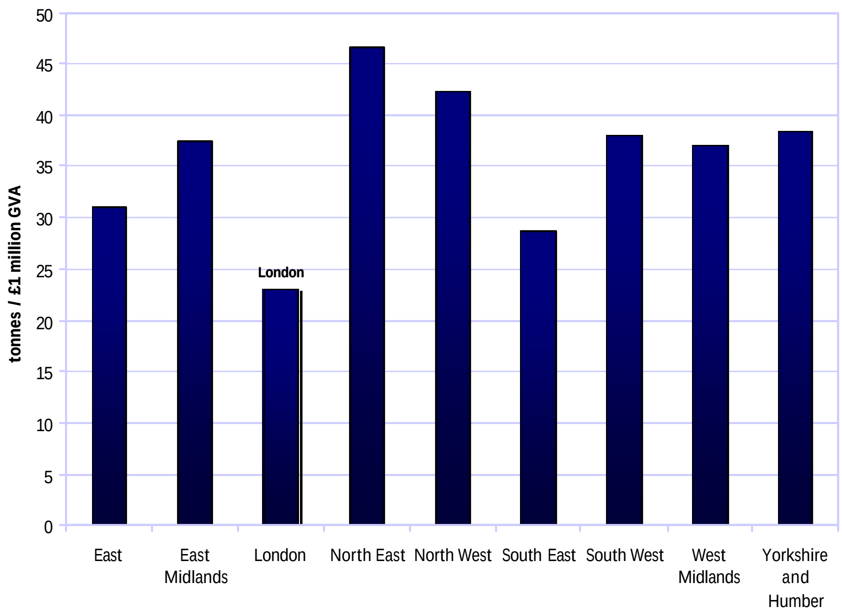


Figure 2.13: Household waste per £1 million of GVA (2002/03)



London has the lowest amount of municipal waste per £1 million of GVA. The level of municipal waste produced in London per £1 million of GVA was roughly 23 tonnes while the average in all other regions was around 37 tonnes.

Source: Defra and ONS

2.6. Water usage

This section provides a brief comparison of water usage among different regions. There is no water consumption data by region. Instead, there is data on the areas operated by water utilities, which normally overlap regional boundaries. Given the geographic proximity to where water utilities operate, the water consumption data from the various utilities have been apportioned to proximate regions to make estimates of regional water consumption. Using per head daily water consumption figures provided by the water utilities and multiplying this by total population for each of the regions, total daily water consumption for the period 2000/01 to 2002/03 has been estimated. Table 2.3 shows per head daily water consumption data while Figure 2.14 shows total daily water consumption estimates for each region. The South East has the highest level of total estimated water consumption, while London's water consumption is second highest. This is to be expected since the per capita usage and populations are higher in the South East and London.

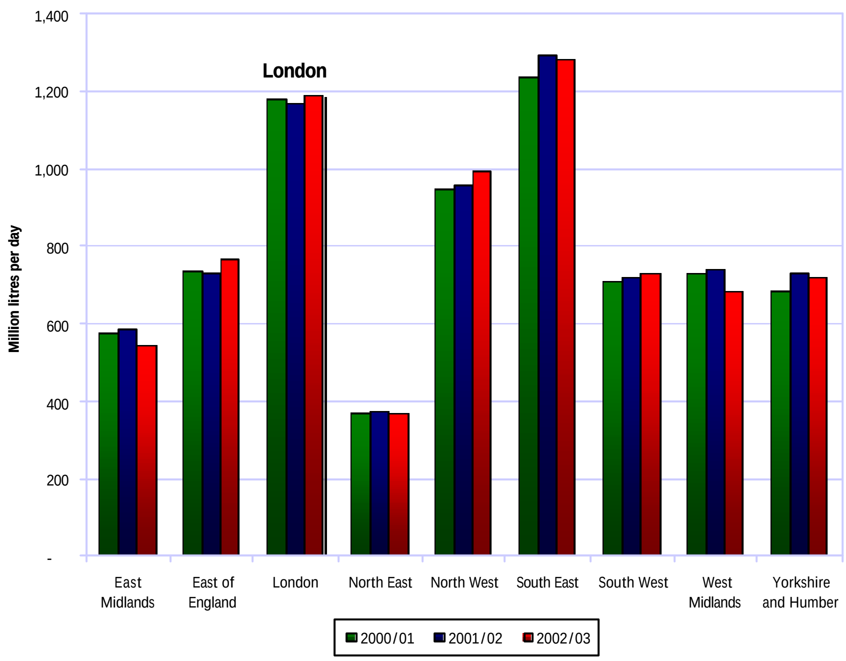
However, looking at water consumption per unit of GVA for the years provided, London becomes the lowest consumer. The East also has a favourable water consumption/GVA ratio. For the period examined, water consumption GVA ratios have improved in all regions. Only in Yorkshire & Humber did water consumption per output first rise and then fall for the period of analysis. This is shown in Figure 2.15.

Table 2.3: Estimated water consumption (litres per capita per day)

	2000/01	2001/02	2002/03
East Midlands	138.3	139.6	128.3
East of England	136.6	135.1	141.4
London	**164.8**	**159.0**	**161.2**
North East	146.9	146.6	144.6
North West	140.4	141.3	146.3
South East	154.8	161.3	158.8
South West	144.3	145.3	146.5
West Midlands	138.3	139.6	128.3
Yorkshire & Humber	138.2	146.6	143.9

Source: Office of Water (OFWAT)

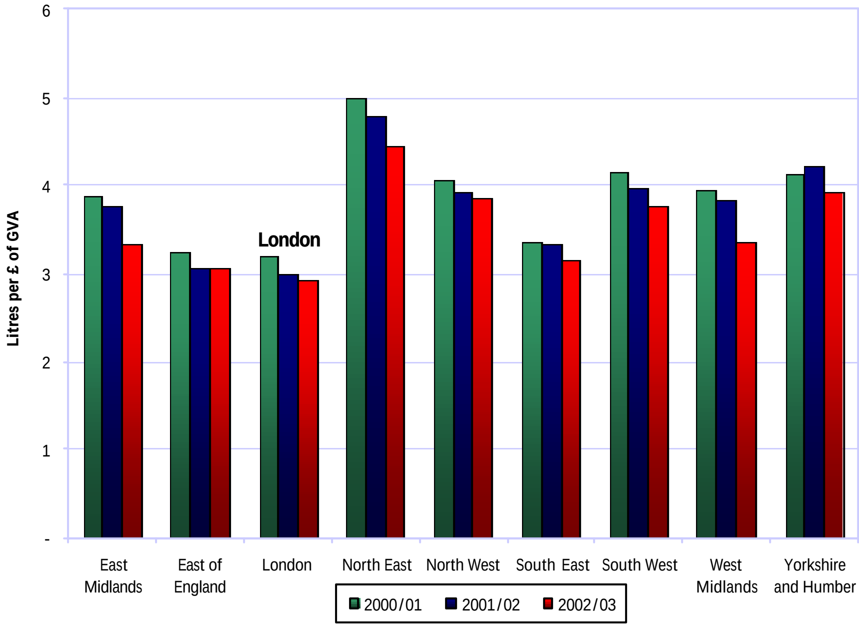
Figure 2.14: Water consumption (million litres per day)



London has the second highest level of water consumption of the regional estimates.

Source: Derived from OFWAT data

Figure 2.15: Water consumption (litres per pound of GVA)



London has the lowest per GVA level of water consumption of all regional estimates.

Source: OFWAT and ONS

Conclusions

On average, household incomes and consumption are higher in London. Household gas sales and electricity distribution in London are the second highest among all regions, only a fraction below total gas and electricity consumption in the South East. However, gas sales per household consumer in London is the second lowest of all regions.

In 2002, London had the third highest per household electricity consumption. Higher electricity consumption in London could in part be caused by the relatively higher affluence of Londoners. This higher affluence might lead to a greater propensity to spend on larger energy consuming durables. It is also due to the larger proportion of households that are privately or socially rented, since private landlords do not have the incentive to improve insulation if tenants are responsible for utility bills[19].

Per GVA estimates show that London uses a low amount of energy per unit of output produced. Using GVA per region for 2002, London households use about 0.09GWh of electricity and 0.37GWh of gas per £1 million of output. This is approximately 29 to 31 per cent lower than the average of all other regions.

[19] Similarly tenants (while it would reduce their energy bills) do not have incentives to improve insulation in rented accommodation since this would be a sunk cost that in most instances is not recoverable from private landlords.

The assessment of household waste and water leads to similar results. Waste generation per head in London is the lowest in England. Waste per £1 million of GVA estimates show that London produces the lowest ratio of waste. Water consumption estimates for all regions are based on crude calculations of per capita usage from water utilities and total population. Water consumption estimates show that London's water consumption was among the highest for the years 2000/01 to 2002/03. Per GVA estimates, however, reveal that London performs better than other regions. What is interesting about most regional data on water consumption per GVA is that there was a year-on-year decline as nominal GVA grew faster than the increase in water consumption.

These are crude estimates of household environmental effectiveness, but in the absence of other data, London's environmental performance is good when its environmental impact/output ratios are compared to other regions. This suggests that the benefits London provides may well outweigh some of the environmental and resource-use costs associated with city living.

3. Transport

This section examines the environmental impact of transport in London and compares London to other regions. The assessment begins by comparing London with other regions at an aggregate level and examines transport trends in all regions for the period 1992/93 to 2002/03. Per capita and per £1 million of GVA estimates are derived to give an indication of the relative environmental efficiency of transport across the regions.

Table 3.1 shows the total vehicle kilometres driven in London and other regions in 2003, the second column also gives an indication of the growth of vehicle kilometres for the period 1993-2003. London has the third lowest total of vehicle kilometres driven, and the percentage increase over the period assessed is the smallest for all regions. With increasing affluence in London[20] a larger rise in vehicle kilometres would be expected, however a substantial proportion (36 per cent) of London households do not own cars. The relatively low level of car ownership and vehicle kilometres in London also reflects the other transport modes available to Londoners, such as trains, buses, the Underground, walking, cycling, light rail and trams. Londoners that do own cars use their cars on average for shorter journeys.

Table 3.1: Total traffic and traffic growth, 1993-2003

Region	All motor vehicles (2003), billion vehicle kilometres	Percentage growth 1993-2003*
East	54	19%
East Midlands	40	22%
London	**33**	**7%**
North East	20	18%
North West	48	19%
South East	86	21%
South west	47	21%
West Midlands	48	18%
Yorkshire & Humber	41	19%

*Notes: *All roads including motorways, rural ‘A’ roads, urban ‘A’ roads and minor roads.*
Source: Department for Transport (DfT)

[20] Incomes in London rose by about eight per cent per annum on average over the 1989-1999 period. Source: ONS, 2004, Household income and gross disposable household income: Regional Trends 38

The concentration of households and high value businesses in London means that London's transport network is perhaps more efficient than is usually thought. Compared to the rest of England, people living in London travel more on average by buses, other public transport and walking. Table 3.2 shows the percentage breakdown by regions for 1999 - 2001. London also has the lowest usage of cars and other private transport. Because a higher proportion of Londoners use public transport and walk, per capita air emissions and CO_2 emissions are lower. Walking also has its benefits in terms of additional exercise. Table 3.3 shows the estimated health benefits associated with walking. The estimated net life extension, compared to the whole population, of those who walk and cycle to work is two years.

Table 3.2: Mode of travel 1999 - 2001 by region (average miles per person per year)

Region	Walk	Car driver	Car passenger	Other private	Local bus	Other public	All modes
East	2%	54%	29%	2%	2%	10%	8,280
East Midlands	2%	54%	31%	4%	3%	6%	7,020
London	**4%**	**39%**	**26%**	**2%**	**6%**	**22%**	**5,452**
North East	3%	47%	31%	4%	8%	7%	5,737
North West	3%	52%	31%	3%	4%	7%	6,333
South East	2%	57%	28%	2%	1%	9%	8,067
South west	3%	53%	33%	3%	2%	6%	6,826
West Midlands	3%	55%	31%	2%	4%	5%	6,513
Yorkshire & Humber	3%	52%	31%	2%	4%	7%	6,483
Great Britain	3%	52%	30%	3%	4%	9%	6,815

Source: DfT

Table 3.3: Impacts of walking on health in London

	(kcal/hr)
Calories consumed for 70kg person driving a car	80
Calories consumed for 70kg person walking at 5km/hr	260
Calories consumed for 70kg person walking at 7km/hr	420

Notes: kcal = kilocalories, hr = hour
Source: AEA Technology, National Health Service (NHS), and Transport for London (TfL) [21]

3.1 Transport emission methodology

The environmental impacts of transport have been estimated by using emission factors from the GLA Economy-Environment model[22]. The GLA's Economy-Environment model provides emission factors for nitrous oxides (NOx), particulate matters (PM_{10}) and CO_2 per kilometre travelled by various types of vehicles. These have been applied to total vehicle kilometres for the years examined to get estimates of transport-related emissions of NOx, PM_{10} and CO_2.

3.2 Transport CO_2 emissions in London

Car and public transport

Total road transport CO_2 emissions by region have been estimated for the years 1993 and 2003. Estimates are calculated from vehicle kilometres driven for those years and CO_2 emission factors provided by the GLA's Economy-Environment model. Table 3.4 shows the 2003 estimated CO_2 emissions as well as the percentage change from 1993. The percentage increase in London was only one per cent, which reflects the small increase in vehicle kilometres in London and the relative improvement in fuel efficiency of vehicles over this period. Further analysis of CO_2 emissions by vehicle type reveals that cars and taxis improved their CO_2 emissions the most, recording an eight per cent decrease in their CO_2 emissions over this period. The improvement in car CO_2 emissions is probably driven by an EU voluntary agreement with car manufacturers to reduce new car CO_2 emissions to 140g/km by 2008[23]. Since London is more affluent than the rest of the country, it might be expected that the car fleet in London is newer and therefore the benefits of the voluntary agreement should occur most quickly in London. Table 3.5 shows estimated CO_2 emission percentage changes by vehicle type.

[21] TfL, February 2004, Making London a Walkable City, The walking plan for London. View: www.tfl.gov.uk/streets/downloads/pdf/walking-plan-2004.pdf
[22] http://www.london.gov.uk/mayor/economic_unit/docs/Enviroseemodelfinalreport.pdf
[23] The average CO_2 emissions of new cars were 191.7 g/km in 1995 and 172.1g/km in 2003, source DfT.

Table 3.4: Total traffic CO_2 growth, 1993-2003

Region	2003 Total transport CO_2 emissions (tonnes)	Percentage growth in CO_2 transport emissions (1993-2003)
East	12,374,481	12%
East Midlands	9,296,072	15%
London	**7,367,728**	**1%**
North East	4,457,187	11%
North West	10,844,679	11%
South East	19,126,932	14%
South west	10,507,650	14%
West Midlands	11,013,175	11%
Yorkshire & Humber	9,455,128	12%
Total	**96,189,687**	**11%**

Source: GLA Economics, DfT and TfL

Above average affluence and alternative modes of transport may have contributed to the improved fuel efficiency of road transport in London. In London, average CO_2 emissions per kilometre by cars have improved by 12 per cent from 1990-2003 and as shown in Table 3.5, this equated to an eight per cent decrease in CO_2 emissions from cars and taxis for the period 1993 to 2003. The scale of the improvement in car fuel efficiency is better understood when compared to the increase in car and taxi vehicle kilometres. For the period 1993 to 2003, car and taxi vehicle kilometres increased by three per cent. This indicates that fuel efficiency improvements are outstripping car and taxi trip demand. The restraining effect of the London congestion charge on car trip demand and the continuing improvements from the voluntary agreement on new car CO_2 emissions should further facilitate lower CO_2 emissions from cars and taxis in London.

Similarly bus emissions measured as CO_2/passenger km have improved by 15 per cent for the period 1992/93 to 2002/03. Some of the improvements are due to an increase in bus patronage. Bus passenger kilometres increased by 43 per cent, while the average number of passengers per bus increased by seven per cent. As with bus patronage increases in London, there has been an increase in bus vehicle kilometres, which increased by 23 per cent. Total CO_2 emissions from buses and coaches increased by 26 per cent for the period 1993-2003 (see Table 3.5).

Estimates of CO_2 emissions attributable to the London Underground's electricity consumption have also been calculated. From 1996/97 to 2001/02, CO_2 emissions per passenger km have decreased by 21 per cent. This comes during a time when there was a 25 per cent increase in passenger kilometres on the London Underground. Table 3.5 shows traffic CO_2 emissions growth in all the regions between 1993 and 2003. Maps of CO_2 emissions by each mode of transport in 2003 is given in the Appendix.

Table 3.5: Total traffic CO_2 growth, between 1993 and 2003

	Two wheeled vehicles	Cars and taxis	Buses and coaches	Freight	London Underground*	Total
East	26%	4%	17%	30%		**12%**
East Midlands	33%	7%	7%	32%		**15%**
London	**32%**	**-8%**	**26%**	**19%**	**-10%**	**1%**
North East	49%	5%	16%	26%		**11%**
North West	32%	6%	3%	27%		**11%**
South East	31%	6%	8%	35%		**14%**
South West	26%	6%	9%	33%		**14%**
West Midlands	30%	3%	7%	28%		**11%**
Yorkshire & Humber	30%	5%	9%	28%		**12%**
Total	**31%**	**4%**	**11%**	**29%**		**11%**

*Notes: *Calculated by using London Underground train kilometres and the electricity consumption factor and electricity emission factor from the GLA Economy-Environment model.*
Source: GLA Economics, DfT and TfL

Commercial transport

CO_2 emissions from commercial vehicles have also been estimated using total vehicle kilometres and emission factors from the GLA Economy-Environment model. Commercial vehicles are defined as:

- Light goods vehicles
- Rigid 2-axle heavy goods vehicles
- Rigid 3-axle heavy goods vehicles
- Rigid 4 plus-axle heavy goods vehicles
- Articulated 3 or 4-axle heavy goods vehicles
- Articulated 5-axle heavy goods vehicles
- Articulated 6 plus-axle heavy goods vehicles.

Table 3.6 shows the increase in CO_2 emissions from commercial vehicles for the period 1993-2003 by region. Commercial vehicle CO_2 emissions increased for all regions. However, London's total increase was smaller than other regions. It should be noted that these estimates assume that average emissions are the same in all regions. Therefore total CO_2 emissions from commercial vehicles are determined by total vehicle kilometres driven. In all regions there was a decrease in usage of 3 and 4-axle articulated vehicles, with a subsequent two to three fold increase in the use of larger 6-axle articulated vehicles. This shift to larger lorries is possibly a reflection of changes in lorry vehicle excise duty (VED) during this period, which provided incentives for using larger vehicles with more axles since their weight distribution produces less track costs than vehicles with fewer axles.

Table 3.6: Total commercial vehicles road traffic CO_2 growth, between 1993 and 2003 by vehicle type.

Region	Light Goods Vehicles	Rigid 2-axle Heavy Goods Vehicles	Rigid 3-axle Heavy Goods Vehicles	Rigid 4 plus-axle Heavy Goods Vehicles	Articulated 3 or 4-axle Heavy Goods Vehicles	Articulated 5-axle Heavy Goods Vehicles	Articulated 6 plus-axle Heavy Goods Vehicles
East	35%	16%	41%	14%	-41%	9%	226%
East Midlands	43%	0%	28%	-4%	-32%	19%	237%
London	**24%**	**-2%**	**19%**	**4%**	**-41%**	**2%**	**215%**
North East	33%	12%	12%	-11%	-42%	-17%	265%
North West	34%	14%	31%	-4%	-42%	3%	237%
South East	40%	16%	43%	13%	-35%	45%	208%
South West	42%	3%	40%	2%	-38%	8%	299%
West Midlands	37%	1%	35%	1%	-43%	20%	230%
Yorkshire & Humber	40%	8%	-16%	-6%	-41%	-7%	256%
Total	**37%**	**8%**	**26%**	**2%**	**-39%**	**12%**	**238%**

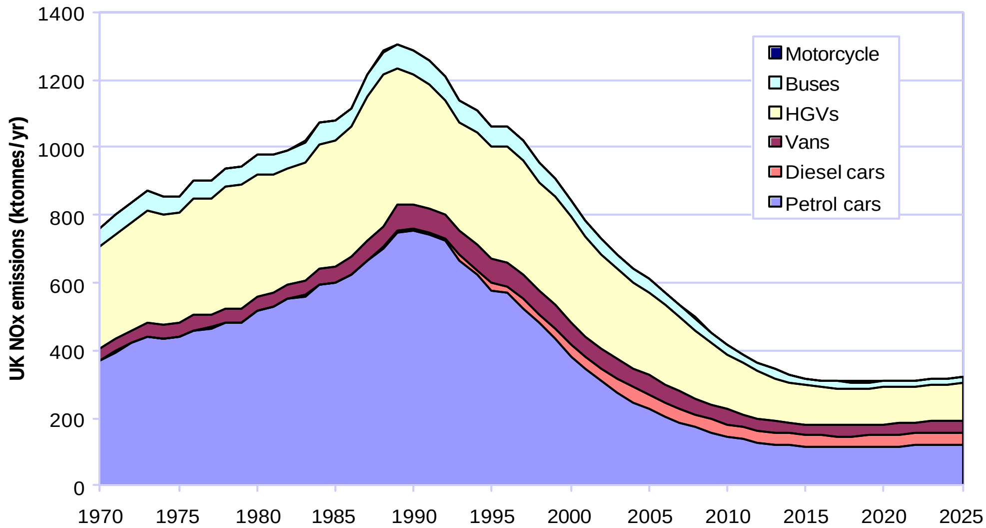
Source: GLA Economics and DfT

There are no obvious improvements in commercial vehicle efficiency in London except that vehicle kilometres grew at a slower pace when compared to other regions. As London's population and economy continues to grow there will be an increase in freight vehicle kilometres as more goods are demanded. However, with London's congestion charge favouring night time deliveries, commercial vehicles might travel at less congested times and are therefore more likely to travel at an optimum speed for better fuel economy (although there is currently little evidence of more night-time deliveries occurring as a result of the congestion charge). Also, as the commercial vehicle fleet becomes newer and more fuel-efficient, and companies improve their efficiency through better logistics management and satellite tracking there might be some improvement in CO_2 emissions from commercial vehicles. The Government's sustainable distribution strategy is also trying to encourage freight onto rail. If this occurs then there may be a reduction in demand for road commercial vehicle journeys within London.

3.3 Transport air quality emissions in London

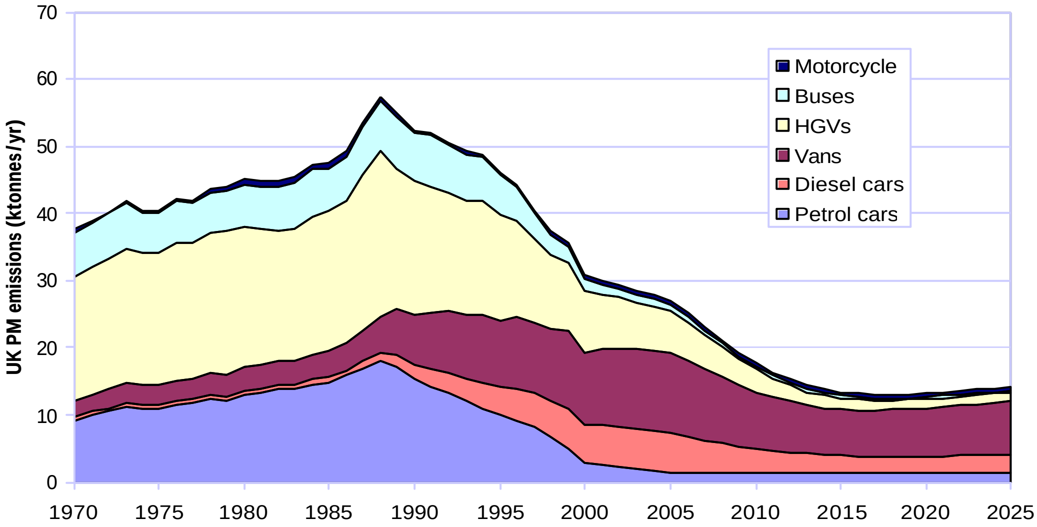
For the purpose of this report, transport air quality emissions are defined as NOx and PM_{10}. Transport air quality emissions have been improving for the UK and London. Figures 3.1 and 3.2 show the NOx and PM_{10} emissions by vehicle types for the UK. UK NOx and PM_{10} emissions peaked in 1989 and 1988 respectively. Since then, NOx and PM_{10} emissions from road vehicles have declined (by 48 per cent and 50 per cent respectively by 2003). Most of these improvements have resulted from EU regulations on air emissions (commonly known as Euro standards) from new vehicles. Euro standards and year of compliance for cars and lorries are given in the Appendix.

Figure 3.1: UK NOx emissions from road transport



Source: Netcen

Figure 3.2: UK PM_{10} emissions from road transport



Source: Netcen

The impacts of air quality emissions such as NOx and PM_{10} are localised. The extent of the environmental and health effects of air pollutants depends on the concentrations of the pollutants and the number of people in close proximity to these concentrations. The health impacts of NOx and PM_{10} tend to be greater in densely populated areas like London. Therefore the measures of air quality effectiveness used in this section should not be perceived as being environmental indicators. Rather the per capita and per unit of GVA measures of NOx and PM_{10} are measures of environmental effectiveness and do not account for the possible health and environmental impacts that these pollutants impose. Thus if the per capita or per unit of GVA measures show that some regions are better than others, this does not mean that the air quality in these regions are satisfactory. Options for further assessing the relative health and environmental impacts of transport related air pollutants in different regions are discussed later in this section (see Tables 3.11, 3.12 and Box 3.1).

To compare London's transport air quality emissions with other regions, the total kilometres travelled in each region and the emission factors from the GLA Economy-Environment model for the years 1993 to 2003 have been used. Table 3.7 shows estimates of NOx and PM_{10} emissions by each region for 2003 as well as the percentage decrease from 1993. The largest percentage decreases have occurred in London with the total levels of NOx and PM_{10} from road transport decreasing by 30 per cent and 44 per cent respectively. In London, NOx has decreased by almost 50 per cent from cars and taxis, but there were also similar reductions in other regions. For the period 1993 to 2003, emissions of PM_{10} from cars and taxis in London reduced by 54 per cent. However, there were similar levels of reductions in other regions.

Table 3.7: Total estimated transport NOx and PM_{10} emissions and decrease between 1993 and 2003

Region	Total NOx, all motor vehicles, (2003, tonnes)	Percentage NOx decrease (1993-2003)	Total PM_{10}, all motor vehicles, (2003, tonnes)	Percentage PM_{10} decrease (1993-2003)
East	50,575	-23%	2,793	-39%
East Midlands	38,625	-21%	2,142	-37%
London	**30,618**	**-30%**	**1,618**	**-44%**
North East	18,537	-24%	984	-40%
North West	43,831	-24%	2,416	-39%
South East	74,779	-23%	4,152	-38%
South West	42,130	-22%	2,319	-38%
West Midlands	45,598	-24%	2,496	-39%
Yorkshire & the Humber	39,638	-23%	2,177	-39%

Source: GLA Economics and DfT

3.4 Per GVA and per capita emission estimates

In terms of passenger kilometres, the greater use of public transport in London improves average fuel efficiency per passenger. If London's transport CO_2 and air quality emissions in terms of per capita and per GVA are measured, London's performance is better than all other regions.

Transport CO_2 per capita and GVA measures

Estimates of CO_2 emissions from transport are presented in Table 3.8. Transport CO_2 emission estimates per GVA and per capita have been deduced from a variety of data sources and assumptions. CO_2 emissions refer only to 2003 road transport emissions as estimated using GLA's Economy-Environment model. Rail emissions have not been estimated because of the difficulty in accurately apportioning passenger rail kms by region.

The estimate for London also includes CO_2 emissions from the London Underground. 2003 CO_2 emissions from the London Underground have been estimated by assuming that energy consumption per passenger km remained constant at 132 watt hour (Wh) from the period 2001/02. This equates to roughly 64g of CO_2 per passenger km. Total passenger kms on the London Underground are also assumed to be constant at 7,367 million, the same as 2002/03. GVA at current basic prices for 2003 have been taken from the ONS[24].

[24] ONS, Regional GVA estimates. View: www.statistics.gov.uk/downloads/theme_economy/NUTS1_Tables_1-8.xls

In terms of CO_2 emissions from transport per £1 million of GVA, London produced less than half of all other regions at 50.6 tonnes of transport CO_2 per £1 million of GVA, while average emissions from all other regions was 134.1 tonnes of transport CO_2 per £1 million of GVA. Per capita emissions are also better in London. London's transport CO_2 emissions per capita was 1.1 tonnes, while the average of all other regions was 2.0 tonnes.

Table 3.8: Total road transport and London Underground CO_2 emissions per GVA and per capita (2003)

Region	Total road transport and London Underground CO_2 emissions	Tonnes CO_2 / £1 million GVA	Tonnes CO_2 / capita
East	12,374,481	129.8	2.3
East Midlands	9,296,072	150.7	2.2
London	**7,839,216**	**50.6**	**1.1**
North East	4,457,187	137.8	1.8
North West	10,844,679	111.1	1.6
South East	19,126,932	128.6	2.4
South West	10,507,650	139.8	2.1
West Midland	11,013,175	142.4	2.1
Yorkshire & Humber	9,455,128	132.7	1.9

Source: GLA Economics and ONS

Air quality per GVA and per capita estimates

Air quality per GVA and per capita estimates are similar to CO_2 measures for London when compared to other regions. To calculate per capita and per output measures for 2003, estimates of NOx and PM_{10} emissions for 2003 have been used (see Table 3.7). GVA and population data for 2003 are the same as that used for CO_2 emissions per capita and per GVA calculations.

In 2003, London's transport NOx emissions per £1 million of GVA were approximately 197kg (see Table 3.9). The average transport NOx emissions per £1 million of GVA from all other regions was approximately three times as high as London's. Per capita NOx emissions in London were 4.1kg while the average of all other regions was 8.3kg.

Table 3.10 shows PM_{10} emissions in London for 2003 were 10kg per £1 million of GVA, while the average of all other regions was approximately 30kg per £1 million of GVA. Per capita PM_{10} emissions from motor vehicles were 0.22 kg in London. The average of all other regions was twice that of London's at 0.45 kg per capita.

Table 3.9: Total estimated motor vehicle transport NOx emissions per GVA and per capita (2003)

Region	Total NOx, all motor vehicles, 2003 (tonnes)	Total motor vehicle NOx (kg) per £1 million GVA (2003)	Total motor vehicle NOx (kg) per capita (2003)
East	50,575	530	9.3
East Midlands	38,625	626	9.1
London	**30,618**	**197**	**4.1**
North East	18,537	573	7.3
North West	43,831	449	6.4
South East	74,779	503	9.3
South West	42,130	560	8.4
West Midlands	45,598	590	8.6
Yorkshire & the Humber	39,638	556	7.9

Source: GLA Economics and DfT

Table 3.10: Total estimated motor vehicle transport PM_{10} 2003 emissions per GVA and per capita

Region	Total PM_{10}, all motor vehicles, 2003 (tones)	Total motor vehicle PM_{10} (kg) per £1 million GVA (2003)	Total motor vehicle PM_{10} (kg) per capita (2003)
East	2,793	29	0.50
East Midlands	2,142	35	0.51
London	**1,618**	**10**	**0.22**
North East	984	30	0.39
North West	2,416	25	0.36
South East	4,152	28	0.51
South West	2,319	31	0.46
West Midlands	2,496	32	0.47
Yorkshire & the Humber	2,177	31	0.43

Source: GLA Economics and DfT

3.5 Transport damage costs

The measures of transport's relative environmental effectiveness in each region have shown that London's transport system is relatively more environmentally effective than other regions. However, these measures do not account for the relative damage caused by each pollutant. It should be noted that damage costs from air quality emissions such as PM_{10} tend to be higher in densely populated areas such as London. Measurements of the concentrations of air emissions and the populations affected by these concentrations are also useful tools when analysing air quality environmental effectiveness. Tables 3.11 and 3.12 show the per capita and per unit of GVA measures of NOx and PM_{10} emissions in each region for 2003, where concentrations of NOx and PM_{10} are calculated as emissions per square kilometre.

Table 3.11: Transport NOx and PM_{10} emissions

Regions	Area (sq kms)	Population	2003 GVA (£ millions)	Transport emissions (2003)	
				NOx (tonnes)	PM_{10} (tonnes)
East	19,120	5,462,918	95,340	50,575	2,793
East Midlands	15,627	4,252,294	61,681	38,625	2,142
London	**1,580**	**7,387,868**	**155,069**	**30,618**	**1,618**
North East	8,592	2,539,363	32,340	18,537	984
North West	14,165	6,804,532	97,618	43,831	2,416
South East	19,096	8,080,280	148,762	74,779	4,152
South West	23,289	4,999,287	75,177	42,130	2,319
West Midland	13,004	5,319,892	77,343	45,598	2,496
Yorkshire & Humber	15,400	5,009,306	71,245	39,638	2,177

Source: ONS and DfT

Table 3.12: NOx and PM_{10} grams/sq km per capita and per £1 million of GVA

Regions	Grams / sq km		Grams / sq km per capita		Grams / sq km per £1 million GVA	
	NOx	PM_{10}	NOx	PM_{10}	NOx	PM_{10}
East	2,645,136	146,077	0.48	0.03	27.74	1.53
East Midlands	2,471,684	137,070	0.58	0.03	40.07	2.22
London	**19,378,481**	**1,024,051**	**2.62**	**0.14**	**124.97**	**6.60**
North East	2,157,472	114,525	0.85	0.05	66.71	3.54
North West	3,094,317	170,561	0.45	0.03	31.70	1.75
South East	3,915,951	217,428	0.48	0.03	26.32	1.46
South West	1,809,009	99,575	0.36	0.02	24.06	1.32
West Midland	3,506,460	191,941	0.66	0.04	45.34	2.48
Yorkshire & Humber	2,573,896	141,364	0.51	0.03	36.13	1.98

Note: Grams/sq km is calculated by dividing emissions by the area data in Table 3.11. Grams/sq km per capita is calculated by dividing grams/sq km in Table 3.12 by population in Table 3.11. Grams/sq km per £1 million GVA is calculated by dividing grams/sq km in Table 3.12 by GVA in Table 3.11.

To account for the range of damages associated with air quality pollutants in urban and rural areas, a cost-benefit analysis of transport emissions in each region would be a useful tool. A detailed cost benefit analysis is beyond the scope of this report, however Box 3.1 gives a brief description of what a regional transport cost-benefit analysis would entail and provides some preliminary crude estimates using average national damage cost estimates.

The damages associated with CO_2 emissions are global. Therefore the estimated damage cost per tonne of carbon is constant across regions. However, the damage costs associated with PM_{10} and NOx are area specific and depend on the size of the population exposed to the level of concentration. The estimates in Box 3.1 do not account for these differences and are therefore only indicative values.

Box 3.1: Potential damage costs from transport emissions

This box shows a simple but useful way to undertake a cost benefit analysis that attempts to estimate monetary values associated with general (CO_2) and specific (NOx and PM_{10}) transport emissions.

Comparing the costs of road transport in each region with its GVA is a potentially useful analysis, as this report's measure of air quality effectiveness takes no account of the damage cost estimates associated with local air pollutants, such as NOx and PM_{10}. Exceeding air quality thresholds can lead to additional incidents of respiratory diseases, hospital admissions, lost time and deaths brought forward*. These health costs are higher in urban areas particularly in urban areas the size of London**. These variations in costs have not been accounted for in this report's simple measure of air quality effectiveness as it does not take into consideration the density of people exposed to NOx and PM_{10} emissions in each region.

By using the 2003 emission estimates from road transport for PM_{10}, NOx and CO_2 from each region and applying damage cost estimates to the tonne of pollutants, the costs and benefits of road transport can be compared. Damage costs from transport emissions of NOx and PM_{10} are taken from work done by AEA technology for Defra (2004)[25]. The values used were the UK average central low and central high, and discounted and undiscounted values. The cost of carbon emissions comes from the Government Economic Service's working paper[26] which suggests that a tonne of carbon emitted costs the UK economy £70, within a range of £35 to £140/tonne of carbon (these values are currently under review by Defra).

Table A: Average damage cost, Great Britain

	Undiscounted		Discounted	
£/tonne	Central low	Central high	Central low	Central high
PM_{10}	11,611	72,349	9,492	59,230
NOx	213	1,343	173	1,098
Carbon	70			

This report's estimates show a range of total costs for each region. If these costs are compared with the transport GVA estimates for each region, the benefits outweigh the costs of transport emissions. For example in London, the damage costs associated with transport emissions of PM_{10}, NOx and CO_2 range from £167 million to £305 million, while the total estimated GVA of transport in London was £10.4 billion in 2003. Please note however, that transport GVA estimates include more than road transport.

[25] View: www.defra.gov.uk/environment/airquality/strategy/evaluation/report-index.htm
[26] Government Economic Service, 2002, : Estimating the Social Cost of Carbon Emissions, Working Paper 140

Table B: 2003 estimated damage costs associated with road transport, £ million

	Total discounted values		**Total undiscounted values**	
	Central low	Central high	Central low	Central high
East Midlands	212	354	218	392
East of England	282	467	290	516
London	**167**	**276**	**172**	**305**
Merseyside	40	66	41	72
North East	101	167	104	185
North West	246	407	253	450
South East	433	709	445	782
South West	238	393	245	434
West Midlands	251	417	258	461
Yorkshire & Humber	216	361	222	399

A simple benefit/cost ratio shows that London has the highest ratio amongst all regions, which is another indication that London's environmental effectiveness is good compared to other regions.

Table C: 2003 transport GVA £ billion (2001 prices)

Region	**Transport GVA**
East Midlands	2.8
East of England	4.2
London	**10.4**
North East	1.0
North West	4.5
South East	6.6
South West	2.5
West Midlands	3.1
Yorkshire & Humber	3.4

Source: Experian Business Strategies

** Reduction in life expectancy due to exposure to low air quality*
*** European Union, Benefits Tables (BeTa) database, http://europa.eu.int*

3.6 Conclusions

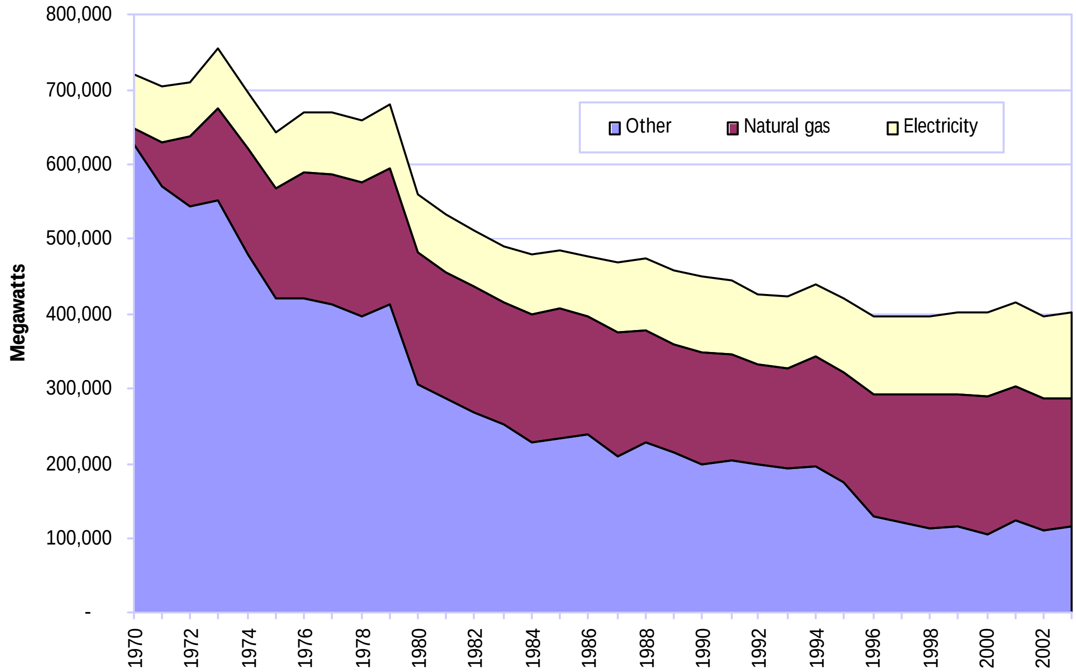
Given the measures of transport environmental effectiveness in this report there are clearly benefits from having large numbers of firms and people living within London. All the transport emission measures in terms of per unit of GVA or per capita, have shown that London performs better than other regions. These measures however do not account for the area specific range of damage costs that are associated with air quality emissions. Additional analysis would therefore be helpful to further examine the costs and benefits to the environment of transport in the different regions.

4. Commercial activity

This section examines the relative environmental performance of the commercial and industrial sector across all regions in England. It is an attempt to show the environmental effectiveness of economic activity in England by estimating per consumer and per pound (£) of GVA usage of resources and environmental amenities attributed to economic activity.

Total industrial energy consumption in the UK in terms of megawatts, declined by 44 per cent during the period 1970 to 2003 as shown in Figure 4.1[27].

Figure 4.1: UK Industrial energy consumption 1970-2003 (megawatts)



Note: Other refers to coal, coke and breeze, other solid fuels, coke oven gas, and town gas. Tonnes of oil equivalent converted to megawatts.
Source: DTI

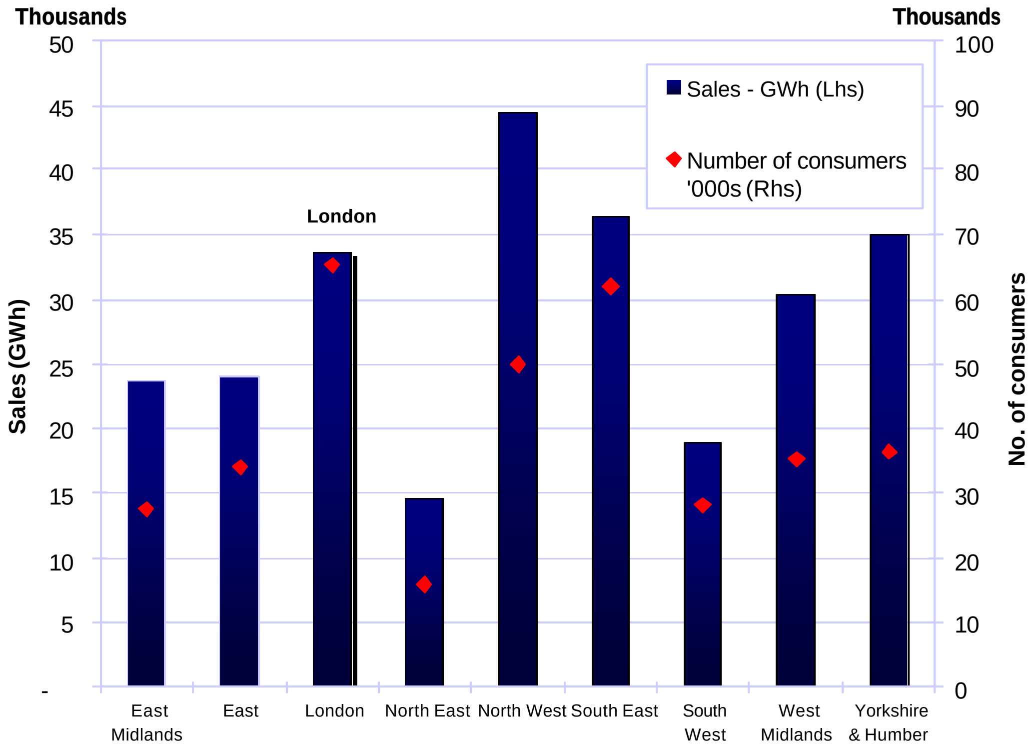
Natural gas sales to industrial final users in the UK rose from 20,790 megawatts in 1970 to 172,159 megawatts in 2003[28]. If gas sales by region for the year 2002 are examined, London's commercial and industrial sector was the fourth largest user of gas, using approximately 34,000GWh or 13 per cent of total gas sales (see Figure 4.2). This is because London has a higher number of commercial and industrial users. There were approximately 65,000 commercial and industrial users in London in 2002 (see Figure 4.2), which represented 18 per cent of total commercial and industrial customers in England. However,

[27] Includes the iron and steel industry, but from 1994 onwards excludes the iron and steel industry's use of fuels for transformation and the energy industry's own use purposes.
[28] Tonnes of oil equivalent converted to megawatts.

because London also has the largest number of commercial and industrial consumers[29], per consumer usage was lowest in London at 514KWh in 2002 (see Figure 4.3). London's per industrial and commercial consumer usage is low because London has fewer energy intensive industries than other regions.

Total commercial and industrial sector electricity consumption in London was 16,000GWh or nine per cent of the total electricity usage by the sector in England for 2002 (see Figure 4.4). Electricity consumption per commercial and industrial consumer was the lowest in London in 2002 at 43,000KWh (see Figure 4.5), while the average for all other regions was approximately 113,000KWh. As with gas sales, electricity consumption in London was the lowest per commercial and industrial sector consumer since London's industries are less energy intensive when compared to other regions.

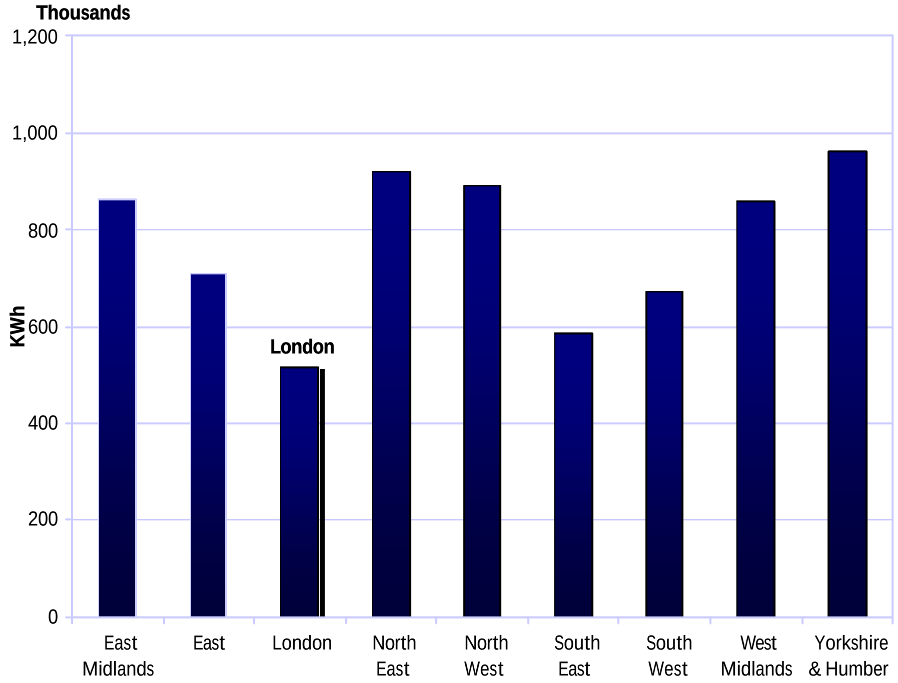
Figure 4.2: Commercial and industrial gas sales and numbers of consumers (2002)



Source: DTI Energy Trends, December 2003

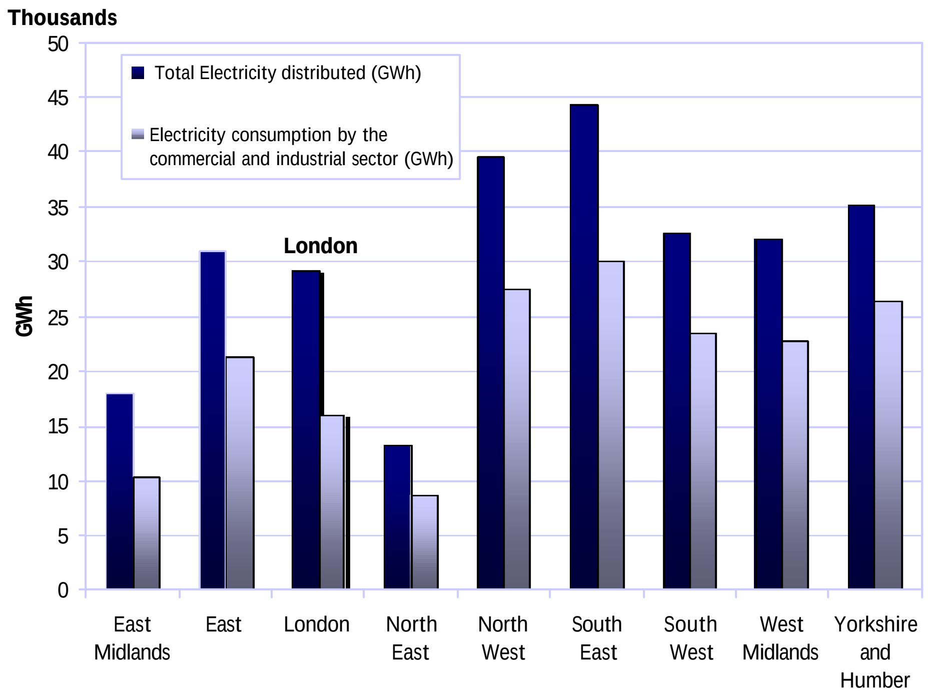
[29] In this report, commercial and industrial consumers refers to business units.

Figure 4.3: Commercial and industrial gas sales per consumer (2002)



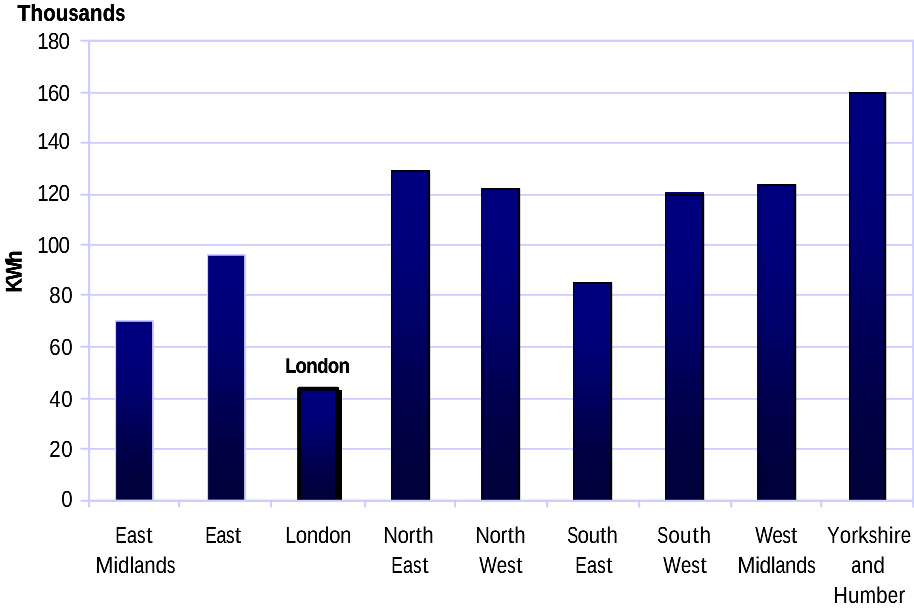
Source: DTI

Figure 4.4: Commercial and industrial electricity usage (2002)



Source: DTI and BRE

Figure 4.5: Per consumer commercial and industrial electricity consumption (2002)



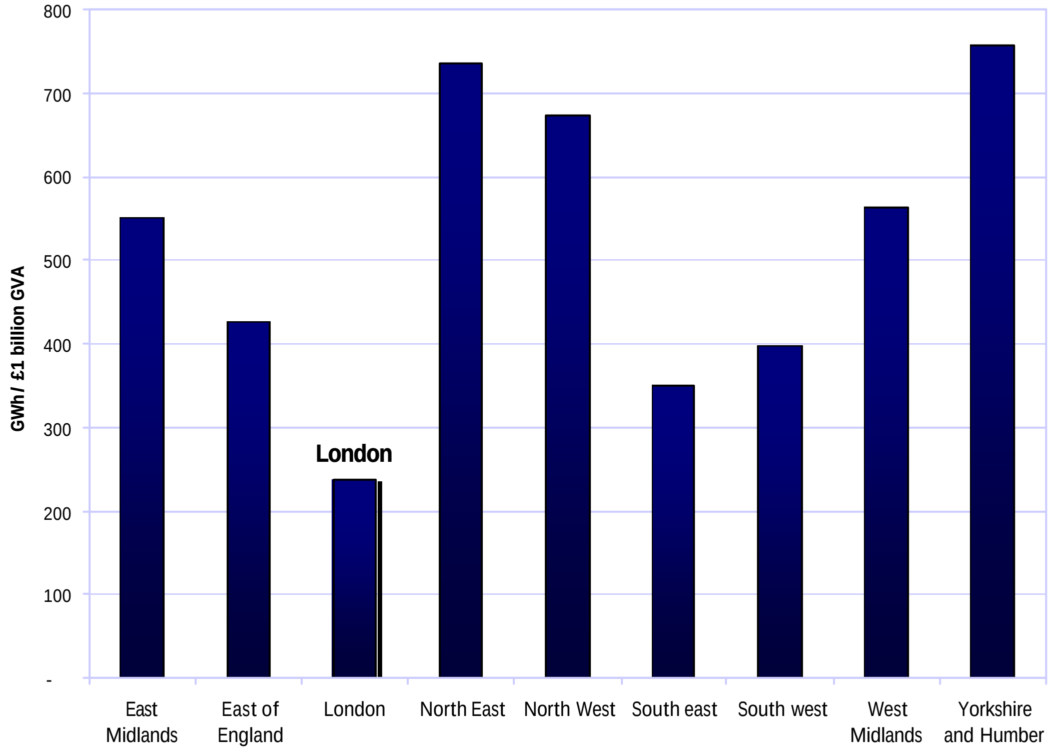
Source: DTI and NOMIS ABI

4.1 Environmental effectiveness of the commercial and industrial sector

This section examines the per unit of GVA effectiveness of environmental and resource use in London's commercial and industrial sector. To measure environmental effectiveness per pound (£) of output, CO_2 emissions from electricity usage have been examined. Gas consumption per pound of output has been used as an indicator of resource usage. It is not possible to measure water usage since there is no reliable data by regions for this indicator.

Natural gas consumption has been used as a proxy for resource usage across all regions in the commercial and industrial sector. Figure 4.6 shows the gas usage per £1 billion of GVA in 2002. Gas usage per £1 billion of GVA for the commercial and industrial sector shows that London is the most efficient user of gas in the generation of output. In 2002, London used 238 GWh of gas per £1 billion of GVA, while the average of all other regions was 557 GWh per £1 billion of GVA.

Figure 4.6: Gas usage in the commercial and industrial sector (GWh/£ billion GVA, 2002)

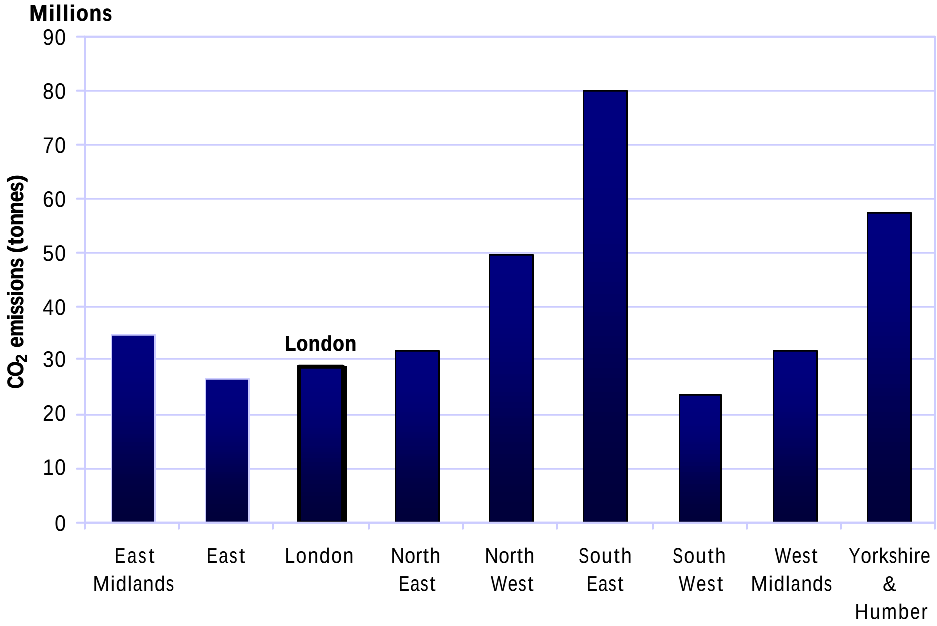


Source: DTI

Figure 4.7 shows 2002 CO_2 emissions from power stations, refineries and other large point sources located in each region. These are measured emissions and are heavily influenced by power stations and energy intensive industries (for example, oil refining and chemicals). In 2002, London's total CO_2 emissions associated with electricity usage were the third lowest of all regions.

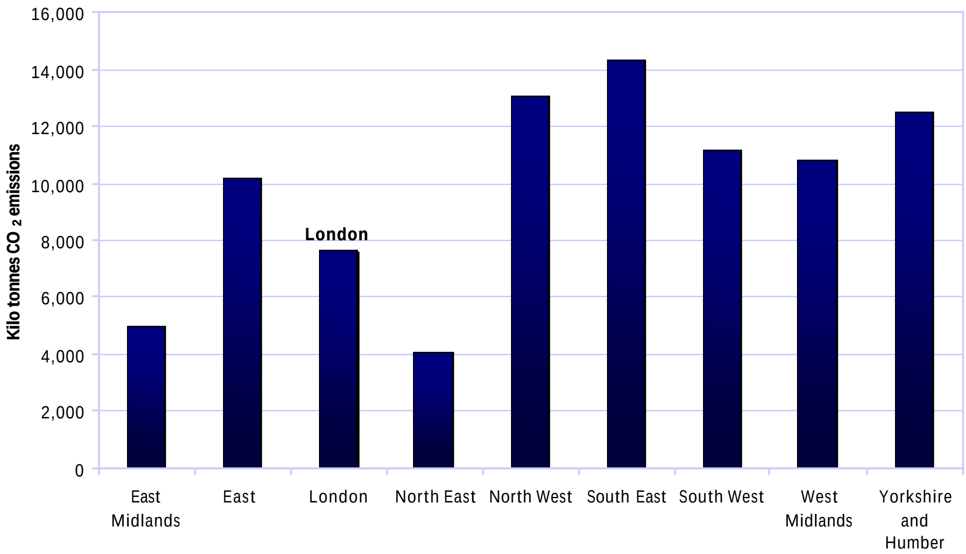
The CO_2 emission factors from the GLA Economy-Environment model have been used to estimate total CO_2 emissions associated with electricity consumption from the commercial and industrial sector. This is shown in Figure 4.8 and indicates that London's commercial and industrial sector was the third lowest contributor to CO_2 emissions in 2002 from electricity use. London's commercial and industrial sector produced an estimated 7.6 million tonnes of CO_2 in 2002. The region producing the least was the North East, which produced approximately 4.1 million tonnes of CO_2. In 2002, the average CO_2 emissions in all regions (excluding London) was approximately 10.1 million tonnes.

Figure 4.7: CO_2 emissions from power stations, refineries and other large point sources, 2002 (tonnes)



Note: These estimates include emissions from power stations, refineries and other large point sources located in each region.
Source: National Atmospheric Emissions Inventory (NAEI)

Figure 4.8: CO_2 emissions from electricity usage in the commercial and industrial sector (2002, kilo tonnes)

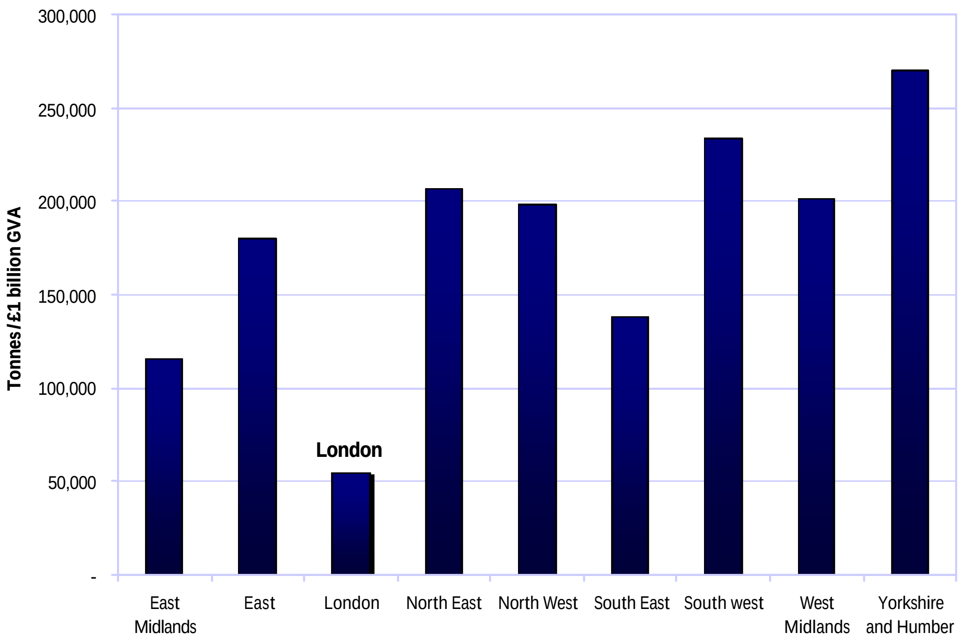


Note: These estimates are based on electricity consumption and CO_2 emission factors from power stations.
Source: DTI and GLA Economy-Environment model

The environmental effectiveness in terms of CO_2 emissions from the commercial and industrial sector is based on 2002 CO_2 emissions and 2002 commercial and industrial GVA estimates for each region. The commercial and industrial sector refers to all sectors except public administration and defence, education, and health. However, it should be noted that CO_2 emissions for the commercial and industrial sector are estimated from total electricity consumed less household consumption of electricity.

Figure 4.9 shows CO_2 tonnes emitted per £1 billion of output in the commercial and industrial sector for 2002. In 2002, London emitted approximately 53 kilo tonnes of CO_2 per £1 billion of GVA (or 53g/£1 GVA) from the commercial and industrial sector. In all other regions the average CO_2 emissions per £1 billion of GVA from the commercial and industrial sector was 193 kilo tonnes.

Figure 4.9: CO_2 emissions from electricity usage per £1 billion of GVA from the commercial and industrial sector (2002, tonnes)



Note: These estimates are based on electricity consumption and CO_2 emission factors from power stations, and regional GVA figures.
Source: DTI and ONS

4.2 Conclusions

Per consumer and per unit of GVA measures have shown that commercial and industrial activity in London is more environmentally and resource efficient than other regions. Higher output per firm, a higher proportion of service type industries and hence less energy intensive usage by firms in London means that London's environmental performance per pound of output is better. Proxy indicators of resource use and environmental effectiveness (gas usage and CO_2), show that on average London's commercial and industrial sector is approximately 50 per cent more efficient in environmental use and 70 per cent more efficient in resource use than other English regions.

5. Conclusion

This section concludes the report and combines most of the environmental effectiveness indicators in the previous sections to determine environmental effectiveness indices for English regions for the period 2002/03. Indices have been calculated to show the relative environmental effectiveness of the various regions in terms of per capita (or per customer) and per pound (£) of output.

5.1 Indices data

Per capita/consumer

The indices are calculated from a combination of selected environmental effectiveness indicators from the previous sections. The first index uses five indicators of consumption and discharge as indicators of environmental effectiveness in terms of per capita (or per customer). The environmental effectiveness indicators of the personal use index are:

- 2002 household gas sales per consumer
- 2002 household electricity consumption per customer
- 2002/03 regular household waste per capita
- 2002/03 total water consumption per capita
- 2003 transport CO_2 emissions per capita.

The primary data for the personal use index reflects the results that were obtained in sections two and three of the report. Table 5.1 gives the household and transport primary data used for each region.

Per unit of GVA index

An index ranking regions by environmental effectiveness per unit of GVA was also calculated. The aggregate primary data used in the per capita analysis were also used for the per unit of GVA index. However, two additional commercial and industrial sector environmental effectiveness indicators were also used; 2002 commercial and industrial sector gas sales and 2002 commercial and industrial sector CO_2 emissions from electricity. The list of environmental effectiveness indicators used for the per unit of GVA index are:

- 2002 household gas sales
- 2002 household electricity consumption
- 2002/2003 regular household waste
- 2002/2003 estimated total water consumption
- 2003 total transport CO_2 emissions
- 2002 commercial and industrial sector gas sales
- 2002 commercial and industrial sector CO_2 emissions from electricity.

This data were divided by the GVA of each region to give regional per pound (£) of output indicators. The subsequent per GVA indicators are shown in table 5.2.

Table 5.1: Per capita or per user primary data (2002/03)

	Household				Transport
	Household gas sales per consumer (KWh)	Household electricity consumption per household (KWh)	Household Waste Collection per capita (tonnes)	Water consumption per head per day (litres)	CO_2 emissions per capita (tonnes)
East Midlands	20,149	4,338	0.52	128.3	2.2
East of England	20,249	4,346	0.52	141.4	2.3
London	**19,436**	**4,358**	**0.46**	**161.2**	**1.1**
North East	20,816	4,312	0.54	144.6	1.8
North West	20,284	4,323	0.58	146.3	1.6
South East	20,435	4,368	0.53	158.8	2.4
South West	17,841	4,362	0.53	146.5	2.1
West Midlands	19,958	4,295	0.51	128.3	2.1
Yorkshire & Humber	19,892	4,317	0.51	143.9	1.9

Table 5.2: Per unit of GVA primary indicators

	Household				Transport	Commercial and industrial sector	
	Household gas sales	Household electricity cons.	Household waste collection	Water cons. 2002/2003	CO_2 emissions	Commercial and industrial gas sales	Commercial & industrial CO_2 emissions (electric)
	GWh /£1 million GVA	GWh / £1 million GVA	Tonnes / £1 million GVA	Million Litres/£ 1 billion GVA	Tonnes / £1 million GVA	GWh / £ 1billion GVA	Tonnes / £1 billion GVA
East Midlands	0.53	0.13	37	9.08	150	551	115,146
East of England	0.40	0.11	31	8.32	129	427	180,151
London	**0.37**	**0.09**	**23**	**7.97**	**50**	**238**	**53,937**
North East	0.69	0.16	47	12.32	146	735	206,084
North West	0.58	0.13	42	10.53	111	673	198,007
South East	0.39	0.10	29	8.51	121	351	138,125
South West	0.39	0.13	38	10.40	144	397	233,718
West Midlands	0.52	0.13	37	9.23	144	562	200,960
Yorkshire & Humber	0.58	0.14	38	10.83	138	757	269,963

Note: Cons = Consumption

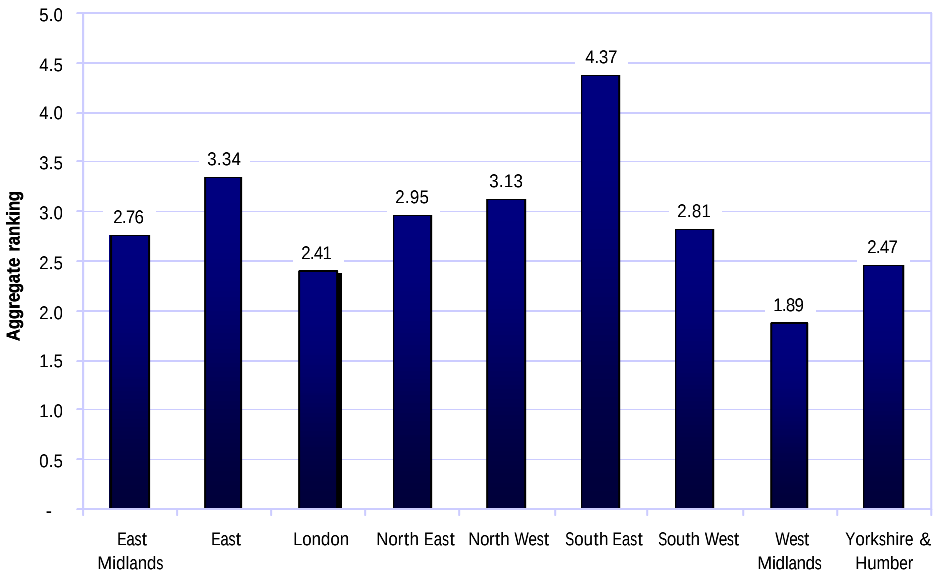
Index methodology
The various indicators were used to rank the regions' environmental effectiveness. For each indicator regions were ranked between 0 and 1 in a process called standardisation or normalisation. A score of zero indicates that the region is the most environmentally effective while a score of one indicates that the region is the least environmentally effective when compared to other regions. All other regions are given a value between 0 and 1.

The detailed index methodology is presented in section A2 of the Appendix.

5.2 Results

Per capita/consumer index
The data in Table 5.1 was used to construct a composite index of environmental effectiveness for all regions. The standardised scores of the environmental effectiveness indicators presented in Table 5.1 were aggregated to give composite indices for each region. Figure 5.1 shows the overall per capita/consumer resource usage indices for each English region. London with a score of 2.41 ranks the second best in terms of resource usage and discharge per capita (or per consumer). The South East performs the least favourable having a score of 4.37. However, the South East and the East have strong economic links with London as they are the largest commuting base for London. Transport CO_2 emissions per capita, one of the indicators used for the index in Figure 5.1, are high for the South East and East as a significant proportion of London's working population commute from these regions.

Figure 5.1: Per capita/consumer regional household environmental effectiveness indicator (2002/03)



Rank
1. West Midlands
2. London
3. Yorkshire & Humber
4. East Midlands
5. South West
6. North East
7. North West
8. East
9. South East

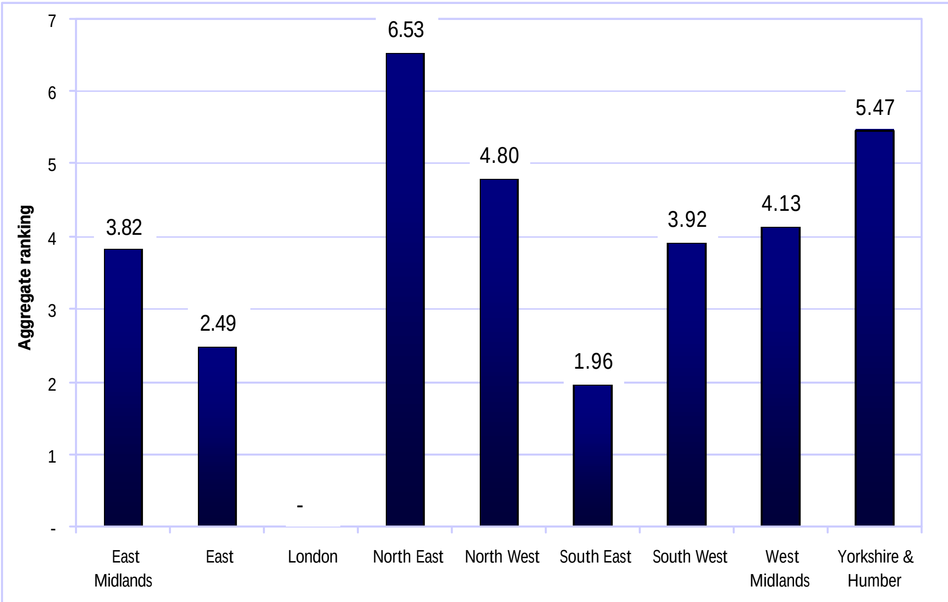
Per unit of output index

To rank regions for their environmental effectiveness per unit of output, the indicators from Table 5.2 were also standardised between 0 and 1 so there could be a meaningful comparison across regions where 0 indicated a higher level of resource efficiency by unit of output.

The standardised rankings of each resource use or discharge per unit of GVA output were aggregated for each of the regions. The summed rankings give an aggregate composite index per unit of output. These rankings and scores are shown in Figure 5.2.

In terms of the selected indicators and economic output, measured as resident GVA, London has the best ranking of all regions. The aggregate index for London, zero, indicates that London uses the least resources and pollutes less per unit of output. Lower numbers indicate a better environmental effectiveness. London performs the best and has a score of zero since it is ranked the best in all of the selected categories in terms of resource usage or emissions per unit of output[30]. The region that is least environmentally effective in terms of output is the North East, which has an aggregate score of 6.53. However, it should be borne in mind that the North East and Yorkshire and Humber have a large number of power generators providing electricity to other parts of the country.

Figure 5.2: Per GVA regional environmental effectiveness indicator (2002)



Rank

1. London
2. South East
3. East
4. East Midlands
5. South West
6. West Midlands
7. North West
8. Yorkshire & Humber
9. North East

[30] Note that a zero score does not mean that London is entirely environmentally friendly or completely environmentally effective.

5.2 Conclusion

By looking at the environmental and resource impacts per capita/consumer and per unit of output, estimates of total environmental effectiveness have been derived for all regions. These are crude estimates, but they show that London performs well in terms of environmental effectiveness in the generation of output and per capita/consumer. Figures 5.2 and 5.1 rank London as the most environmentally effective region in terms of per unit of output and the second most environmentally effective region in terms of per capita/consumer.

The results indicate that concentrations of people and economic activity in city spaces such as London can result in lower environmental impact per capita or per unit of output. The economic efficiencies of cities seem to also translate into environmental impact efficiencies. The obvious question that arises from this analysis is what the environmental impact would be in other regions if London did not exist? Would there be more environmental damage if the population and economic activity that currently exist in London was dispersed to other regions? Given the per capita and per output indicators in other regions, if cities such as London did not exist then it is possible that the total environmental impact would be larger and the environment in other regions would also be worse. Policy makers also need to ask whether the benefits of some types of economic activity outweigh their damage costs and what measures might be needed to reduce their impact?

Although the estimates of per capita and per output environmental effectiveness indicators presented in this paper are simple, they are a first attempt to examine and compare the environmental impact of economic and social activity between London and other regions. Additional work would be beneficial to further examine the environmental costs and benefits of communities and economic activity in different regions at a local level. One possible way of doing this would be to estimate the monetary cost of the environmental impacts and to compare this with the gross value added estimates of each region. By doing this, cost and benefit impacts could be compared on the same scale.

Appendix

To calculate total household electricity consumption for each region, average electricity consumption factors were multiplied with the number of households for each type of tenure. Commercial and industrial electricity consumption was obtained by subtracting household electricity consumption from the total electricity distributed in each region.

Table A1: Household tenure

	Total households	Owned	Social rented	Private rented
East Midlands	1,732,482	1,250,574	303,381	144,154
East	2,231,974	1,622,870	368,630	196,591
London	**3,015,997**	**1,704,719**	**790,371**	**467,083**
North East	1,066,292	678,407	294,723	76,987
North West	2,812,789	1,948,010	564,573	240,037
South East	3,287,489	2,431,459	458,965	334,392
South West	2,085,984	1,524,122	282,265	233,150
West Midlands	2,153,672	1,498,066	443,644	157,266
Yorkshire and Humber	2,064,748	1,395,895	434,176	187,810

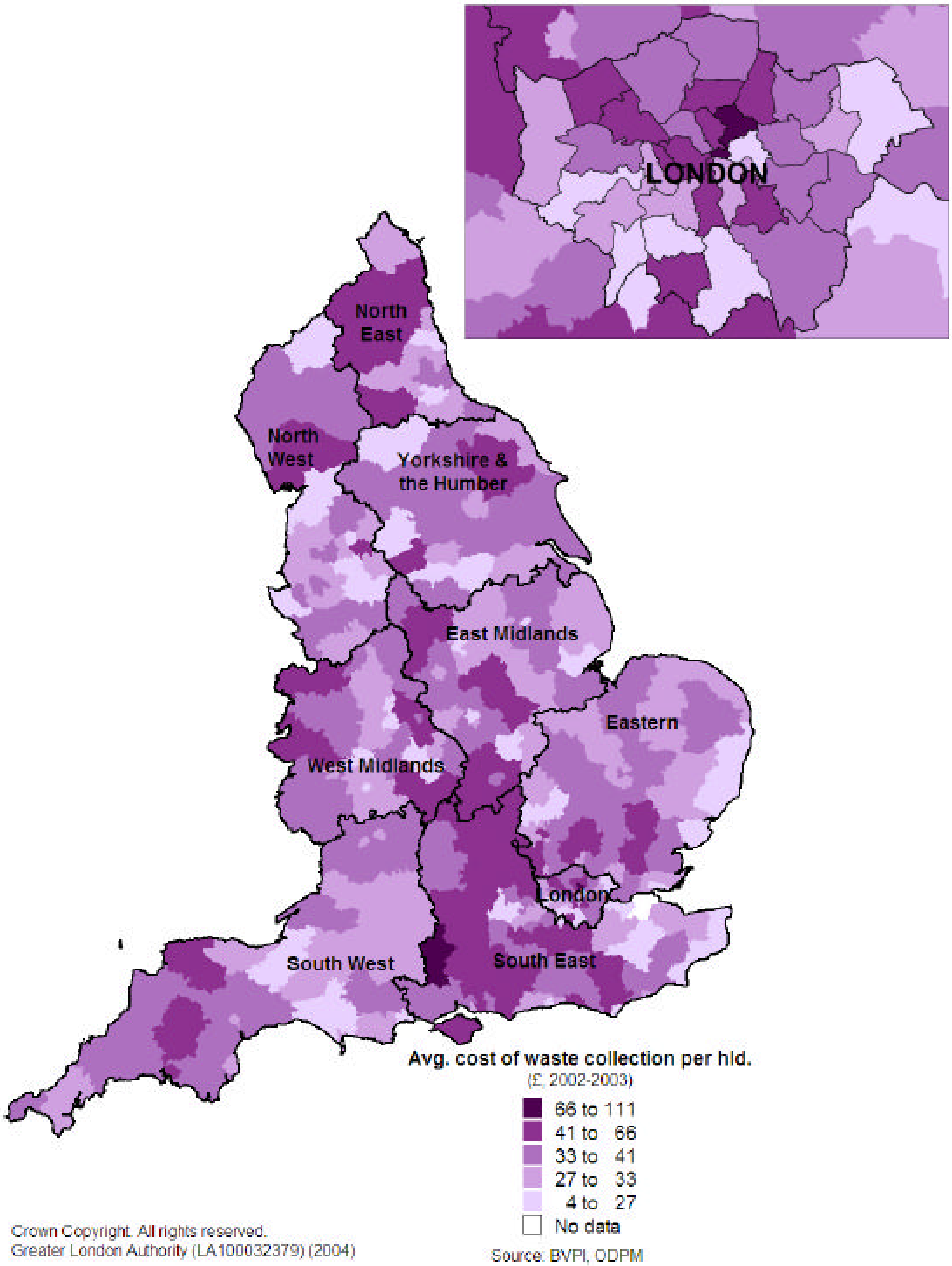
Source: ONS, Neighbourhood statistics

Table A2: Energy consumption existing stock

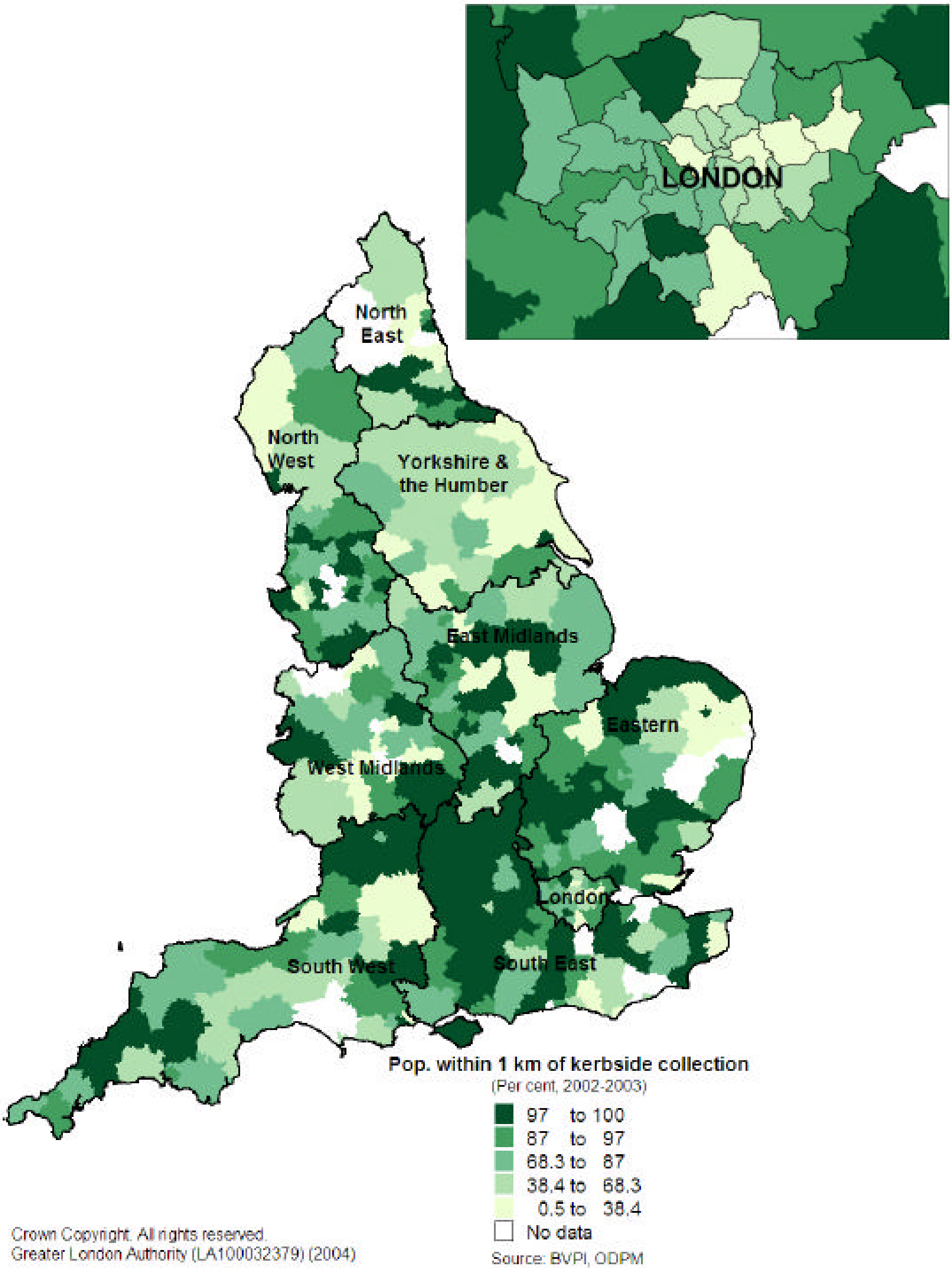
Tenure	Electricity	Gas	SAP	Household in the UK
	(kWh)	(kWh)		(thousands)
Owner occupied	4,443	16,158	45	15,994
Rented local authority	3,654	12,390	43	4,826
Private rented	5,079	13,262	36	1,727
Rented housing association	4,439	11,565	47	1,113
Total				**23,660**

Source: BRE, 1999, Energy Efficiency Profiles for the housing stock

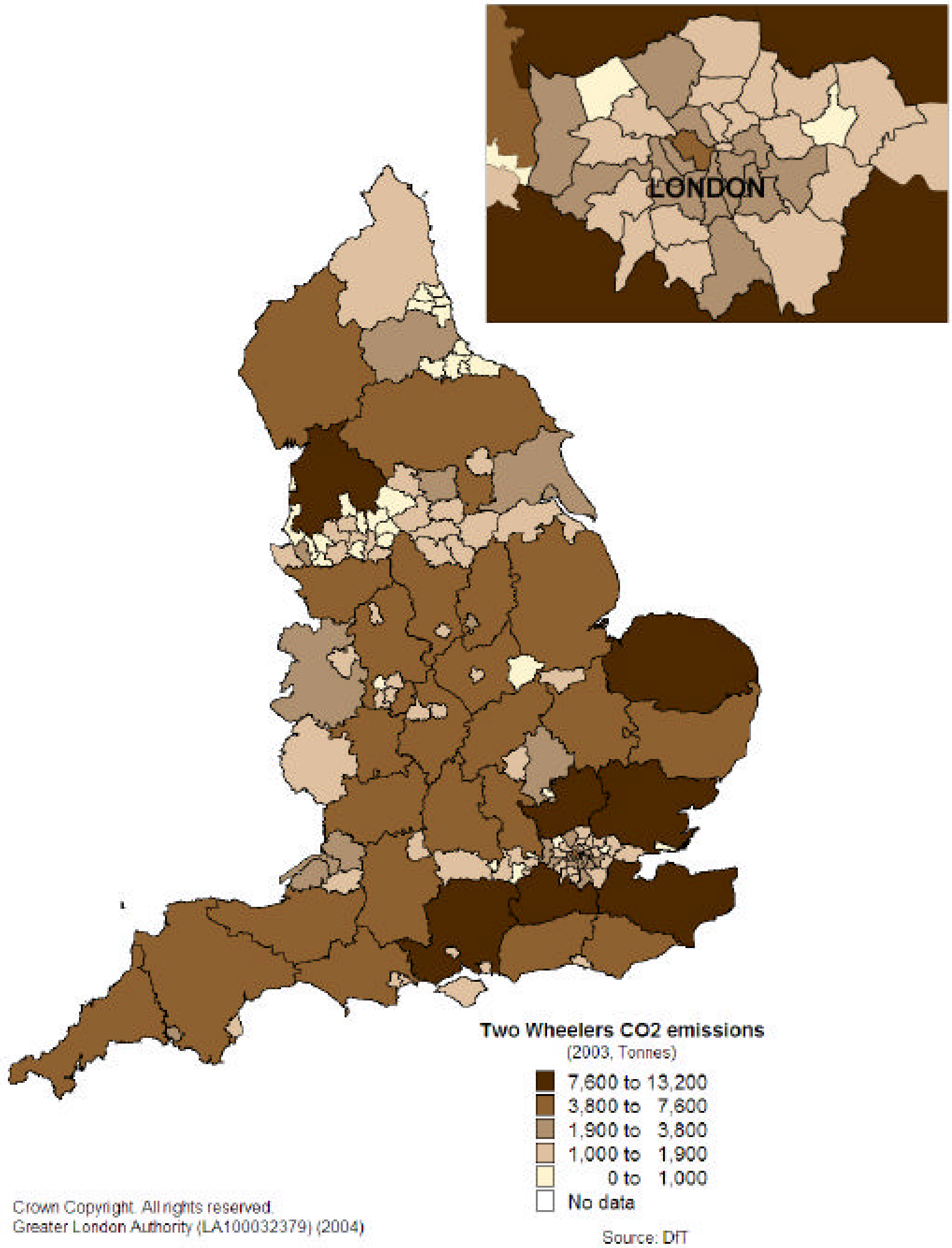
Map A1: Map of average cost of waste collection per household



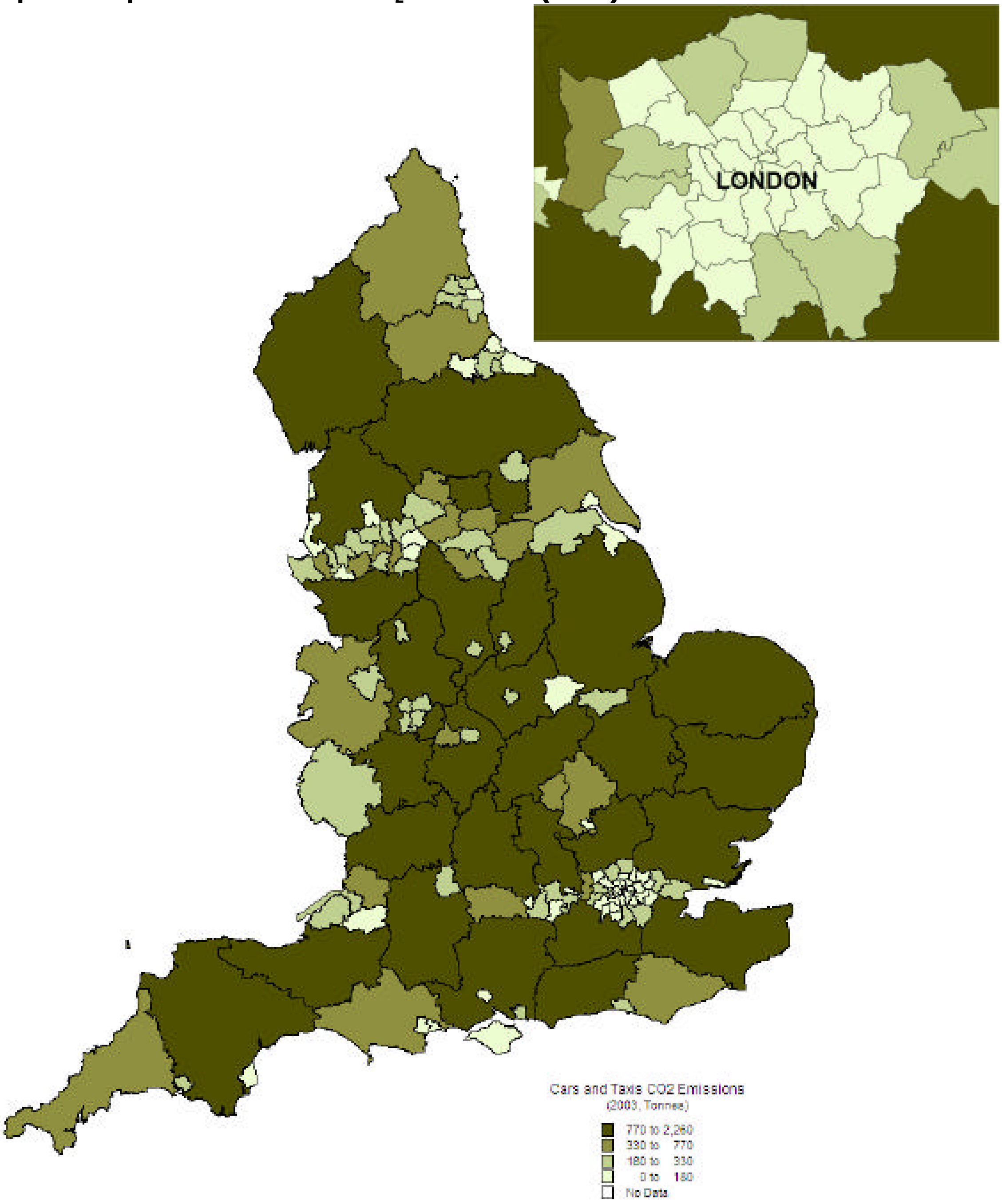
Map A2: Map of population within 1km of kerbside collection (per cent)



Map A3: Map of two wheelers CO_2 emissions (2003)

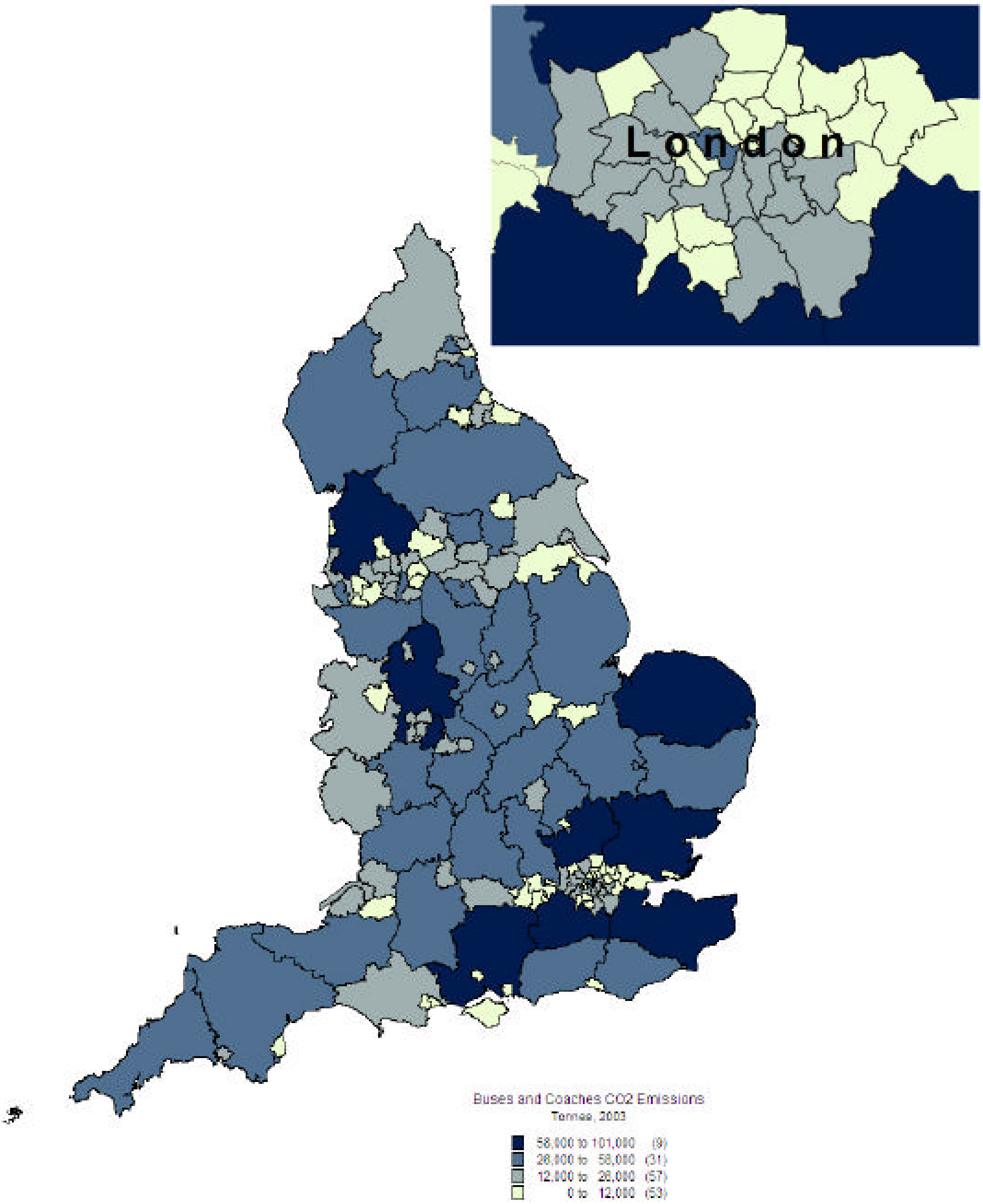


Map A4: Map of cars and taxis CO_2 emissions (2003)



Source: DfT

Map A5: Map of buses and coaches CO_2 emissions (2003)



Source: DfT

Map A6: Map of total freight vehicles CO_2 emissions (2003)

Source: DfT

Table A3: EU emission standards for diesel cars g/km *

Tier diesel	Date	NOx	PM
Euro 1†	1992.07	-	0.14 (0.18)
Euro 2, IDI	1996.01	-	0.08
Euro 2, DI	1996.01[a]	-	0.10
Euro 3	2000.01	0.50	0.05
Euro 4	2005.01	0.25	0.025

*Note: *Excluding cars over 2,500 kg which meet N_1 Category standards*
† Values in brackets are conformity of production (COP) limits.
a - until 1999.09.30 (after that date DI engines must meet the IDI limits)
Source: www.dieselnet.com/standards/eu/ld.html

Table A4: EU emission standards for petrol cars g/km *

Tier petrol	Date	NOx	PM
Euro 1†	1992.07	-	-
Euro 2	1996.01	-	-
Euro 3	2000.01	0.15	-
Euro 4	2005.01	0.08	

*Note: *Excluding cars over 2,500 kg which meet N_1 Category standards*
† Values in brackets are COP limits
Source: www.dieselnet.com/standards/eu/ld.html

Table A5: EU emission standards for heavy duty diesel engines, g/kWh

Tier	Date & category	CO	HC	NOx	PM
Euro I	1992, <85 kW	4.5	1.1	8.0	0.612
	1992, >85 kW	4.5	1.1	8.0	0.36
Euro II	1996.10	4.0	1.1	7.0	0.25
	1998.10	4.0	1.1	7.0	0.15
Euro III	*1999.10, EEVs only*	*1.5*	*0.25*	*2.0*	*0.02*
	2000.10	2.1	0.66	5.0	0.10 0.13*
Euro IV	2005.10	1.5	0.46	3.5	0.02
Euro V	2008.10	1.5	0.46	2.0	0.02

Note: For engines of less than 0.75 dm^3 swept volume per cylinder and a rated power speed of more than 3000 min^{-1}
Source: www.dieselnet.com/standards/eu/ld.html

A1. Index methodology

To rank each region depending on its resource usage or discharge, each set of data was 'normalised' or 'standardised' to rank regions between 0 and 1. This methodology was developed to eliminate problems associated with comparing data from heterogeneous data sets and is similar to the methodology used for the compilation of vulnerability indices. Standardised variables permit additive or multiplicative averaging, with the average being called a composite index. The formula follows the methodology used by Briguglio (1992; 1993; 1995, 1997) and Chander (1996) and subtracts the minimum value of a range of observations of a given variable from each observed value:

i. Subtract minimum value (Min X) from a range of observations ($X_1 \ldots X_j$) from the observed value (X_i).
ii. Subtract the minimum value from the maximum value (Max X) of the same range of observations.
iii. Divide the result of (i) by the result of (ii).
iv. Repeat this procedure for all observations of variable X.

The formula for standardising a given observation in an array of observed values for a given variable is therefore:

(Xi – Min X) / (Max X – Min X)

Where:
Xi is an observed value in an array of observed values for a given variable.
Max X is the highest value in the same array.
Min X is the lowest value in the same array.

The range of standardised values of variable X will thus be between 0 and 1. If X_i is the minimum in the range of values, then X_i would have a value of zero. However, if it is the maximum in the range, then it would take a value of 1. All the components of the index can then be summed on the basis of equal or varying weights assigned to each component.

The most important shortcomings of this methodology are that the weights for averaging the components are arbitrarily chosen and the distribution of the normalised variables are influenced by outlier observations. For the purpose of this report, the individual components have not been weighted. The composite index is therefore a simple aggregation of all the individual normalised indicators.

All regions were therefore ranked according to their resource usage using their normalised or standardised scores. Scores closer to zero indicate less resource use per capita/per customer or per unit of output. The standardised scores for each resource and region were summed to give an aggregate ranking across all regions.

Since for example there are seven indicators in the per unit of GVA index, the range of estimates for the aggregate index is from zero to seven. Thus, if a region ranked best in all seven indicators it would get an aggregate score of 0 and conversely if a region ranked least effective in all seven indicators it would get an aggregate score of seven.

Glossary – Conversion factors and conversion matrices

Conversion factors

1 tonne of UK crude oil =	7.55 barrels
1 tonne =	1,000 kilograms
1 gallon (UK) =	4.54609 litres
1 kilowatt (kW) =	1,000 watts
1 megawatt (MW) =	1,000 kilowatts
1 gigawatt (GW) =	1,000 megawatts
1 terawatt (TW) =	1,000 gigawatts

All conversion of fuels from original units to units of energy is carried out on the basis of the gross calorific value of the fuel. More detailed information on conversion factors and calorific values is given in Annex A of the Digest of UK Energy Statistics.

Conversion matrices

To convert from the units on the left hand side to the units across the top multiply by the values in the table.

To:	Thousand toe	Terajoules	GWh	Million therms
From	***Multiply by***			
Thousand toe	1	41.868	11.630	0.39683
Terajoules (TJ)	0.023885	1	0.27778	0.0094778
Gigawatt hours (GWh)	0.085985	3.6000	1	0.034121
Million therms	2.5200	105.51	29.307	1

To:	Tonnes of oil equivalent	Gigajoules	kWh	Therms
From	***Multiply by***			
Tonnes of oil equivalent	1	41.868	11,630	396.83
Gigajoules (GJ)	0.023885	1	277.78	9.4778
Kilowatt hours (kWh)	0.000085985	0.003600	1	0.034121
Therms	0.0025200	0.105510	29.307	1

Note that all factors are quoted to 5 significant figures

Source: DTI Energy Trends, September 2004

Key terms

BRE	Building Research Establishment
CO_2	Carbon Dioxide
COP	Conformity of production
DETR	Department of the Environment, Transport and the Regions
DfT	Department for Transport
DTI	Department of Trade and Industry
ECF	Energy cost factor
EU	European Union
g	Gram
GDP	Gross Domestic Product
GLA	Greater London Authority
GVA	Gross Value Added
GWh	Gigawatt hour
hr	Hour
kcal	Kilocalories
kg	Kilogram
km	Kilometres
KWh	Kilowatt
MSW	Municipal social waste
NAEI	National Atmospheric Emissions Inventory
NHS	National Health Service
NOx	Nitrous oxides
ODPM	Office of the Deputy Prime Minister (ODPM
OFWAT	Office of Water Services
ONS	Office for National Statistics
PM_{10}	Particulate matters
RDF	Refuse derived fuel
SAP	Standard Assessment Procedure
sq	Square
TfL	Transport for London
VED	Vehicle excise duty
Wh	Watt hour

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Online resources

AEA Technology http://www.aeat.co.uk

Building Research Establishment www.bre.co.uk

Defra, Key facts about waste and recycling: http://www.defra.gov.uk/environment/statistics/waste/kf/wrkf02.htm

Department of Trade and Industry www.dti.gov.uk

DieselNet: www.dieselnet.com/standards/eu/ld.html

European Union, Benefits Tables (BeTa) database http://europa.eu.int

Greater London Authority	www.london.gov.uk
Greater London Authority, Publications	www.london.gov.uk/gla/publications/
National Atmospheric Emissions Inventory	www.naei.org.uk
ODPM, Best Value Performance Indicators	http://www.bvpi.gov.uk/pages/Index.asp
ONS, Neighbourhood statistics	http://neighbourhood.statistics.gov.uk

ONS, Regional GVA estimates
www.statistics.gov.uk/downloads/theme_economy/NUTS1_Tables_1-8.xls

NAEI	www.naei.org.uk/
Netcen	http://www.netcen.co.uk/

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Hindi

यदि आप इस दस्तावेज की प्रति अपनी भाषा में चाहते हैं, तो कृपया निम्नलिखित नंबर पर फोन करें अथवा नीचे दिये गये पते पर संपर्क करें

Vietnamese

Nếu bạn muốn có văn bản tài liệu này bằng ngôn ngữ của mình, hãy liên hệ theo số điện thoại hoặc địa chỉ dưới đây.

Bengali

আপনি যদি আপনার ভাষায় এই দলিলের প্রতিলিপি (কপি) চান, তা হলে নীচের ফোন্ নম্বরে বা ঠিকানায় অনুগ্রহ করে যোগাযোগ করুন।

Greek

Αν θέλετε να αποκτήσετε αντίγραφο του παρόντος εγγράφου στη δική σας γλώσσα, παρακαλείστε να επικοινωνήσετε τηλεφωνικά στον αριθμό αυτό ή ταχυδρομικά στην παρακάτω διεύθυνση.

Urdu

اگر آپ اِس دستاویز کی نقل اپنی زبان میں چاھتے ھیں، تو براہ کرم نیچے دئے گئے نمبر پر فون کریں یا دیئے گئے پتے پر رابطہ کریں

Turkish

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Arabic

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Punjabi

ਜੇ ਤੁਹਾਨੂੰ ਇਸ ਦਸਤਾਵੇਜ਼ ਦੀ ਕਾਪੀ ਤੁਹਾਡੀ ਆਪਣੀ ਭਾਸ਼ਾ ਵਿਚ ਚਾਹੀਦੀ ਹੈ, ਤਾਂ ਹੇਠ ਲਿਖੇ ਨੰਬਰ 'ਤੇ ਫ਼ੋਨ ਕਰੋ ਜਾਂ ਹੇਠ ਲਿਖੇ ਪਤੇ 'ਤੇ ਰਾਬਤਾ ਕਰੋ:

Gujarati

જો તમને આ દસ્તાવેજની નકલ તમારી ભાષામાં જોઇતી હોય તો, કૃપા કરી આપેલ નંબર ઉપર ફોન કરો અથવા નીચેના સરનામે સંપર્ક સાધો.

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